INCORPORATION OF LOW VALUE CEREALS OF BUNDELKHAND REGION IN BREAD

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CERTIFICATION

This is to certify that the work entitled ***"INCORPORATION OF LOW VALUE CEREALS OF BUNDELKHAND REGION IN BREAD"*** is a piece of research work done by **Ms Shubhangi Nigam** under my supervision at the Institute of Food Science and Technology, Bundelkhand University, Jhansi (U.P). She has put in attendance of more than two hundred days as required by the Bundelkhand University, Ordinance during the research period.

To the best of my knowledge and belief the thesis:

(I) embodies the work done by the himself,

(II) has been duly complete,

(III) is upto the standard both in respect of content and language
for being referred to examiner.

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"With the grace of god every arduous task accomplishes"

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Chapter 1

Introduction

Bread is an excellent source of calories, protein, vitamins and minerals. Bread has been an essential element of human diets for centuries in all regions, except for rice growing South East Asia. Bread is baked food made from dough of ground or milled cereal grain, usually wheat flour. Only wheat flour contains gluten, a substance that supplies the structure needed for leavening (Sharma et al., 1998).

The Indian bakery industry is dominated by the small-scale sector with an estimated 50,000 small and medium-size producers, besides the 15 units in the organized sector. Apart from the nature of the Industry, which gravitates to the markets and caters to the local tastes, the industry is widely dispersed also due to the reservation policies (relating to the small scale industries) of the government. The two major bakery products, biscuits and bread, account for 82% of all bakery production. The unorganized sector accounts for about half of the total biscuit production estimated at 1.5 million tons. It also accounts for 85% of the total bread production and around 90% of the other bakery products estimated at 0.6 million tons **(Indian_ bakery, 2006)**.

The bakery industry in India has now occupied a significant place in industrial sector. The estimated annual production of bakery products in India is in excess of 3 million tonnes of which bread accounts for nearly 50 percent and biscuits 37 percent in volume terms, in the organized sector. The bakery sector in India is one of the largest

segments of food processing industries with an annual turnover of about 900 million dollars (Sharma et al., 1998). Bakery products are ready- to-eat processed foods. The products like breads, sweet buns, toasts or cookies are widely consumed as source of nutrients, including calories, throughout the world. The qualities of these products are influenced by recipe ingredients, baking conditions and storage **(Englyst et al., 1982)**. Bakery products are no longer considered fancy or luxury tea time snacks, but have become an essential and significant component of dietary profile of the population. Wheat flour is the basic ingredient in bakery products. The protein quality of wheat is inferior to that of most cereals because it is deficient in lysine and threonine **(Ilamaran et al 2002)**. To improve the nutritional quality of baked products, the use of single flour is replaced by the composite flour. Bakery products are ready to eat, convenient to use and possesses satisfactory nutritional quality. The per capita consumption of bakery products is about 2.5 kg per year in India as compared to 150 kg in other developed countries, indicating greater potential for the industry as compared to the present situations **(Jayaram, 1990 and Krishnappa et al., 2002).**

The bakery industry has an important role to play in economic development of the country. This industry holds immediate and perspective future. It has also considerable scope for the additional investment and employment with very little capital requirements per unit compared to the other industries. Many bakery businesses fail and bakery-owners see their dreams of success shattered **(Kamaliya et al., 2004).**

Wheat production is about 70 million tonnes per year in India and counts for approximately 12 per cent of world production. Being the second largest in population, it

is also the second largest in wheat consumption after China, with a huge and growing wheat demand. The New Delhi government will find it difficult to significantly improve prospects for the food grain year from an all-time record of 78.40 million tonnes achieved in 2007-08 **(India's wheat production plateauing 2008).**

Wheat flour is known to be a complex mixture of starch (70-80%), proteins (8-18%), lipid (~2%), pentosans (~2%), enzymes and enzyme inhibitors and other minor components (Mac Ritchie 1984, Pomeranz 1988). A good bread quality flour encompasses an optimum blend of all these constituents. The technological importance of wheat flour is attributed mainly to its gluten proteins (water-insoluble complex proteins). This stems from the fact that upon fractionating wheat flour into gluten, starch, lipid and water soluble; gluten alone possesses viscoelastic properties i.e. it exhibits rubber-like characteristics. Also, if the gluten proteins are removed from the flour, then the property of forming viscoelastic dough is lost. The unique viscoelastic properties of gluten proteins are responsible for uniqueness of wheat flour (**Khatkar et al.1997**).

The nutritional significance of bakery products is well recognized. Attempts are being made to enrich the products with high quality non wheat proteins. Products such as bread, biscuits, cookies, cake and doughnuts can serve as good vehicles for carrying the added proteins to target population for use in combating the protein malnutrition prevalent in many parts of the world **(Chavan & Kadam, 1993).** The bread wheats, durum wheats and *Triticale* are technologically different.

Barley (*Hordeum vulgare L)* is one of the founder crops of old world agriculture. Barley is grown as a commercial crop in some one hundred countries world-wide and is one of the most important cereal crops in the world. Barley assumes the fourth position in total cereal production in the world after wheat, rice, and maize, each of which cover nearly 30% of the world's total cereal production. Barley has an important role as a feed grain in most western countries. In Finland barley constitutes 50 % of all cultivated cereals. Approximately 81% of annual barley production is used for feed 9 %, for seed, 8 % for malt and alcohol production, and only 2% for human consumption **(The Agricultural Economics Research Institute 1986)**. It is estimated that about 85% of the world's barley production is destined for feeding animals, while the rest is used for malt production and food consumption but also for production of starch either for food use or for the chemical industry. Barley grain based feed are used on pig and cattle farms. Barley flour is primarily used in combination with other flour to make multigrain breads.

Food produced from barley is a good source for many nutrients such as protein, fiber, minerals and B- vitamins. The nutritive value of barley is generally, similar or that of main cereals staple foods. The composition of the barley grain and the percentage of macronutrients are similar to those of wheat although it is considered to have a poorer nutritive value than wheat because of its higher fiber content. Carbohydrates, proteins and fats are something around 73.5%, 12.5% and 2.3% in barley and 72.5%, 13.7% and 1.9% in wheat respectively. Likewise, the concentration of vitamins and minerals in both cereals are close to each other.

Soybean (*Glycine Max.*) is a typical legume seed differing in colour, size and shape depending on the variety. Proximate analysis of the whole bean shows that protein (40%) and oil (21%) make up approximately 60% bean, the remaining one third consisting of non-starchy carbohydrates, includes polysaccharides, stachyose, raffinose and sucrose. Nucleic acids are present only in minor amounts. The chemical composition of soybeans varies some wheat with different varieties, geographical locations and climatic conditions. For the past several decades, soybean has become an increasingly important agricultural commodity, with a steady increase in annual production both in the united state (U.S) and the whole world. Currently, global production is estimated at 165 million metric tons. The major producing countries are US, Brazil, China, India and Argentina. More than half of the U S production which constitutes more than 50% of world's total production is exported. Soybean on an average contained 8.1 percent of moisture. Soybean varieties differ in their physico-chemical characteristics and these variations influence the quality characteristics of products prepared from the seeds (**Snyder and Kwon 1987**).

Soybean has its origin perhaps in ancient China. It is use in human diets in various from. It has been called 'Miracle bean', 'Golden bean', 'Nugget of Nutrition' and 'Cow of China'. **Cricle** and **Smith (1972)** have pointed out that the name soy flour may be misleading, since its composition is totally different from that of the popular product commonly known as flour, i.e. wheat flour. They suggested alternative names such as "Defatted soy solid'' (as non-fat milk solid) or "Soy powder" or "Soy pulverate".

Soybean protein is a rich source of lysine and tryptophan but poor in sulphur containing amino acid (Eggum, 1973). Cereal based foods are formulated with protein sources such as milk or legume flour to improve protein content and quality **(Cheryan et al. 1979, Milner 1969, Adeyemi et al, 1989).** In developing countries the most widely used source of protein is soybean, having been considered as one of the least expensive when compared to egg, milk, meat or cowpea (Oyenuga 1968). The challenge of processing soybean for human consumption is to develop acceptable low-cost soy foods which are of high protein quality high caloric value, better shelf-life and to make them available to the nutritionally vulnerable groups. Incorporation of soybean in popular traditional Indian foods is likely to help in acceptability of soy blended foods/ snacks **(Sumedha, S. Deshpande et al.2004)**. Neumann (1928) reported that as early as 1896, Timpte in Magdeburg (now in East Germany) had introduced what was probably the world's first commercial defatted soy flour; it contained 51.6% protein and 0.51% fat. It must have been made by solvent extraction. Soy flour is already in use as an ingredient in bread making (Kent-Jones T W et al. 1967).

In addition to produce whiter bread, soy flour would also add to the protein content of the bread. Research has shown that soy contains chemo-preventive agents (Isoflavones) acting against human cancer development and there are promising signs that soy may also reduce bone loss and inhibit atherosclerosis. Therefore, the incorporation of soy containing products into the diet has become increasingly more significant in the food industry. Blending of barley flour, soy flour into white bread causes a significant decrease in loaf volume and a decrease in acceptability. The ability to

produce acceptable bread with appropriate texture and volume relies on understanding the interaction between starch and gluten which results in the proper formation of a gluten network. The development of the bread with new formulation requires laboratory testing and consumer acceptance. There is requirement of bread with better quality in terms of nutrition and texture. The work on the above is very scanty therefore; the incorporation of barley flour, defatted soy flour and gluten powder with white flour was carried out with the following objectives:

1. To study the physico- chemical and nutritional characteristics of white flour, barley flour and defatted soy flour.
2. To incorporate and optimize the level of barley flour and defatted soy flour in white flour to prepared bread on the basis of sensory evaluation.
3. To optimize the level of gluten powder and surface active reagent (SSL) in barley flour and defatted soy flour incorporated bread on the basis of sensory evaluation.
4. To establish relationship between textural profile and sensory properties.
5. To study the shelf-life of bread.

Chapter 2

Review of Literature

Bread is the most common bakery product made from the wheat flour which is popular worldwide. It is generally agreed that the uniqueness of wheat is due to its bread making quality. The typical characteristics of wheat are that it contains a peculiar protein complex known as gluten which on hydration of flour provides the binding characteristics and at the same time renders it extensibility. The gluten forms the skeletal frame work of bread and biscuits and the starch, which through baking is gelatinized in the gluten framework, gives bulk and formation. It is the gluten characteristics, which determine the loaf volume of bread and texture and finish of biscuits. During the last three decades a number of new products have been developed and introduced in the market. These includes high fibre bread, reduced calorie breads, special formula enriched breads, trend setting cookies with their long shelf life **(Sharma and Jackel, 1984)**. Fermented and non-fermented breads are prepared from millets **(Husle et al., 1980)**.

At present about 1.5 lakh tonnes of vital wheat gluten is produced in the world. The high protein content, unique structural and adhesive characteristics of wheat gluten make it a useful additive to produce good quality bread with high volume, fine texture and resilient crumb from inconsistent quality of commercially available flour. It is the natural protein derived from wheat or wheat flour. It is a protein- lipid-carbohydrate complex (protein- 83%, lipids- 8.3%, starch-6.0%, ash-0.7 %) obtained when flour is hydrated with water. When the starch is washed away with more water the gluten coheres as an elastic insoluble rubber like mass, which can be dried to give a cream coloured

powder. This rubber like mass is elastic and capable of holding gas **(Amarjeet Kaur et al 2004).** Increases in water absorption by addition of gluten have been reported by **Czarnecka et al (1979).**

2.1 DEVELOPMENT IN BAKERY INDUSTRY

In India, there are over 75,000 bakeries ranging from the very small corner bakeries to large whole sale / commercial bakery chains. The biggest challenge the bakery industry is facing today is the inconsistent quality of wheat flour which is the prime ingredient. There is a tremendous market opportunity to add value in the preparation of bakery products, initially via bakery mixes to be followed by frozen batters/dough pre baked and eventually ready-to-eat products. Premixes can be those leavened by chemicals, by yeast, by aeration or those leavened by chemicals and flavoured with fermentation products from yeast, still others can be non leavened ones, bakery premixes offer many advantages like uniformity, simplicity, reduced inventory, cost control, labour saving, tolerance to handling and sanitation, while dusty nature of the products sieving of ingredients could be serious disadvantages. Major ingredients used in premixes are flour, leavening agents, shortening, sugar, emulsifiers and processing aids reported by **Oberoi R et al (2004).**

Bakery industry in India is the largest of the food industries with an annual turnover of about Rs. 3000 crores **(Small Industries Service Institute, 2003).** The two major bakery industries, viz., bread and biscuits account for almost 82 percent of the total

bakery product like bread, biscuits, pastries, cakes, buns, rusks etc., most of which are in the unorganized sector, is estimated to be in excess of 30 lakh tonnes. The production of bread and biscuits in the country, both in the organized and unorganized sectors, is estimated to be about 15 lakh tonnes and 11 lakh tonnes respectively. Of the total production of bread and biscuits about 35 percent is produced in the organized sector and the remaining 65 percent in the unorganized sector as reported by Food Processing Industries Department, 2000 **(Bist Y, 2006).**

The production of bakery products has increased from 5.19 lakh tonnes in 1975 to 18.95 lakh tonnes in 1990, recording four fold increases in 15 years. Among the bakery products, biscuits occupy an important place as they contribute over 33 percent of total products processed. The growth rate of bakery products is estimated at an average of 9.8 percent per annum. The demand for bakery products will continue to increase in future. The estimated growth of 9.8 percent is on the lower side considering the present potentiality of bakery products, particularly in rural areas, where about 70 percent of the population lives. Encouraging trends in the consumption of bakery product by population of lower and middle income groups indicate vast scope for consideration of nutritional enrichment of bakery products **(Small Industries Service Institute, 2003)**.

The review includes the literature of production, importance and composition of wheat, barley and defatted soy flour.

2.2 WHEAT

Wheat is the world's most important cereals crop in terms of production (550-600 million tones per annum) and nearly two third of it is used for human consumption: the rest one-third is utilized for seed, feed and non-food applications (**Shewery and Tatham 1994**). The quantity and diversity of enjoyable and satisfying products made from wheat are remarkable. These include various types of breads, biscuits, cakes, doughnuts, pasta products, breakfast cereals and different varieties of chapatti. Most wheat is consumed in the form of various types of baked goods in most countries of the world (**D'Appolonia 1993**). Further more, it is generally agreed that the uniqueness of wheat is due to its breadmaking quality, bread (leavened or unleavened) having been an important staple food for thousands of years. Among plant crops, only wheat flour and to a limited extent, rye flour has the ability to form a dough that retains gases and produces a baked product, particularly leavened bread, with the desired eating qualities (**Laszity 1980; Shewry et al 1994**). Many of the components of wheat have a significant effect on the processing properties of wheat flour. Reactions and interactions of the components determine the milling quality, dough-mixing properties and bread making quality of wheat. The effects strongly depend on the type of baking process and the bread formulation. Therefore, some elements of the chemistry of the baking process are still uncertain.

Wheat is being cultivated in an area of 26.62 million hectares with an annual production of 72.06 million tonnes and average yield of 2.707 tonnes per hectares for the year 2003- 2004 (**Directorate of Economics and Statistics, 2004**). India is the second largest producer of wheat in the world. About 90.00 percent area is under bread wheat

(Triticum aestivum), while 9.00 percent of the area is occupied by macaroni wheat *(Triticum durum)*, and remaining 1.00 percent by emmer wheat *(Triticum dicoccum)* **(Reddy et al., 1998)**.

Wheat is one of the most important crops in the agricultural economy of India as wheat is the largest cereal grain crop of the world and second largest after rice in India **(Singh, et al., 2000)**. The common wheats are grouped in to the following four major categories viz., hard red spring, hard red winter, soft red winter, winter and spring white wheat. Wheat grown in India is classified as spring wheat and is cultivated in winter season. Three main species namely bread wheat (*Triticum aestivum)*, macroni wheat (*T. durum*) and emmer wheat (*T. dicocum)* are grown in different parts of the country **(Singh and Malik, 1987)**. Bread is considered the main food source in Jordan. It provides the majority of energy and protein requirement. Durum wheat *(Triticum durum Desf.)* is considered most important since it is used to produce most bread types, in addition to balady bread reported by **Ereifej et al.,(2006)**.

2.2.1 Wheat Flour

Wheat flour is unique among the cereal grain flours and when mixed with water, its protein component forms an elastic network capable of holding gas and developing a firm spongy structure during baking **(Sharma et al.,1998)**. Gluten proteins, present in wheat also called storage protein, consist of two major types of proteins: gliadins and glutenins. They account for about 70 percent of total wheat protein **(Kasarda et al., 1976)**. Gluten is formed when flour is wetted with water and interaction occurs between

the gliadins and glutenins **(Wrigley and Beitz, 1988)**. Gluten proteins are important in determining flour end-use properties because of their unique quality to form viscoelastic doughs. In general, gliadins are believed to contribute dough extensibility and glutenins to dough strength and elasticity **(Wall, 1979).**

Wheat flour with specific quality characteristics is required for the preparation of different bakery product **(Rao, 1969)**. Manufacture of bread requires hard flour whereas biscuits and cakes require soft wheat flour. In addition the particle size and extraction rate of flour are important for biscuits, as they require long shelf life from 9-12 months. Flour of uniform granularity (particle size 30-35 microns) has been found to be very useful in biscuit manufacture **(Pomeranz, 1988)**. The flour should have 8.0 to 10.0 percent proteins, 20-30 ml sedimentation value, less than 80 minutes pelshenke value. Less than 15 cm^2 dough strength and less than 0.85 extensibility/ stability ratio **(Rao., 1978)**.

Seventeen soft wheat cultivars from four classes of US soft wheats were selected for evaluation of physicochemical characteristics. In addition to the wide variations in flour particle size, flour of Madsen, which had the highest amount of damaged starch, had the second smallest particle size (63μm). Flour protein content was relatively low, ranging from 6.7 percent for Hyak to 8.9 percent for Madsen because short patent flour of a 45 percent extraction was used **(Yamamota et al. 1996).** Proximate composition of wheat fraction shown in Table-2.1 and 2.2 .

Table 2.1 Proximate composition of wheat fraction

	Moisture (gm)	Protein (gm)	Fat (gm)	Minerals (gm)	Fibre (gm)	Carbohydrate (gm)	Energy (Kcal)
wheat (whole)	12.8	11.8	1.5	1.5	1.2	71.2	346
wheat flour (whole)	12.2	12.1	1.7	2.7	1.9	69.4	341
wheat flour (refined)	13.3	11	0.9	0.6	0.3	73.9	348
wheat germ	5.2	29.2	7.4	3.5	1.4	53.3	397

Table 2.2 Mineral composition in wheat fractions

	Calcium (mg/100gm)	Phosphorus (mg/100gm)	Iron (mg/100gm)	Carotene (µg)	Thiamine (gm)	Riboflavin (gm)	Niacin (gm)
wheat (whole)	41	306	4.9	64	0.45	0.17	5.5
wheat flour (whole)	48	355	11.5	29	0.49	0.29	4.3
wheat flour (refined)	23	121	2.5	25	0.12	0.07	2.4
wheat germ	40	846	6	-	1.4	0.54	2.9

Source: Gopalan et al., (1987)

2.2.2 Composition of Wheat Flour

2.2.2.1 Moisture

The values of moisture content ranged from 6.6 to 11.30 percent in Indian wheat flour reported by **Bain** and **Irvin (1965), Tara et al., (1969), Rao (1969) Nagi & Bains (1983). Tsen et al., (1973), Sathe et al., (1981), Lorenz (1983), Hoojjat** and **Zabik (1984), Narayan (1991), Donald (1992) and Rawat et al., (1994)** also reported the moisture content in the same range. **Weegels (1993), Kaur et al., (2004) and Gill et al., (2006)** reported higher range (13.3 to 16 percent) of moisture content in wheat flour.

2.2.2.2Fat

Singh et al., (1978), Popli and **Dhindas (1980)** and **Shekhara** and **Shurpalakar (1983)** reported the fat content (1.09 to 3.06 percent) in Indian wheat. **Haridas** and **Rao et al., (1976), Ballester et al., (1988), Bourne (1989), Mishra (1991) and Onweluzo and Iwezu (1998)** also determined the fat content in the same range. **Narayan (1991)** and **Dogra et al (2004)** reported lower values (0.90 percent) of fat content in wheat flour.

2.2.2.3 Protein

The protein content in US wheat flour ranged from 8.0 to 15.6 percent reported by **Finney et al .,(1949), Bell** and **Simmonds (1963)** and **Zeheny et al., (1971). Shekara & Shurpalekar (1984), Singh et al., (1989), Mc Donald (1992), Patel, Rao (1995), Sharma and Chauhan (2002), Dubey et al.,(2002), Dogra et al.,(2004), Dingra et al.,(2004) and Gill et al.,(2006)** reported similar values of protein content in different varieties of wheat flour. **Fustier et al.,(2007)** analyzed the composition and physico-

chemical properties of patent, middle cut and clear flour fraction of soft wheat and reported 7.41, 9.65 and 12.7 percent protein, respectively.

2.2.2.4 Total Ash

Shurpalekar et al ., (1976), Haridas Rao et al., (1976), Kaur and Bain (1979) and Nagi and Bain (1983), Gains et al.,(1994) reported 0.43 to 0.82 percent ash in white flour obtained from different Indian wheat. **Rao et al.,(1969), Diwan et al (1982), Shekara and Shurpalkar et al.,(1984), Gonzallez- Galan et al.,(1991), Mishra et al., (1991)** and **Bala et al.,(2004)** observed the value of ash content in the same range as above. **Rawat et al.,(1994)** reported slightly higher value (1.0 percent) of ash content. **Bourne (1989), Hinton (1990)** reported much higher value (1.3 to 1.8 percent) of total ash content. **Fustier et al., (2007)** analyzed the patent, middle cut and clear flour fractions of soft wheat flour and found the ash content 0.4 percent, 0.57 percent and 0.99 percent, respectively.

2.2.2.5 Calcium

Rawat et al., (1994) and Dogra et al., (2004) observed 120 mg/100g and 20 mg/100gm of calcium content in wheat flour, respectively. **Mishra et al., (1991)** reported 42.0 mg/100g and 68mg/100g calcium content in UP-319 and RR-21 variety, respectively. **Tara et al., (1969)** reported calcium content of 26.5 to 58.7 mg/100g in white flour of different wheat varieties but **Bourne (1989)** observed calcium content of 43 and 38 mg/ 100gm in the flours of 95 and 91 percent extraction rate. A higher range of

calcium content (64 to 139 mg/100g) in improved varieties of Haryana and Punjab wheat was observed by **Popli and Dhindsa (1980).**

2.2.2.6 Phosphorus

Rawat et al., (1994) and **Dogra et al., (2004)** observed 150 mg/100g and 75 mg/100g of phosphorus content in wheat flour, respectively. **Tara et al., (1969)** and **Popli** and **Dhindas (1980)** reported a range of 210.4 to 413.0 and 149 to 373 mg/100g, respectively. **Bourne (1989)** reported phosphorus content of 330 and 280 mg/100gm in 95 and 91 percent extraction wheat flour. **Mishra et al., (1991)** reported a range of 175 to 210 mg/100g of phosphorus in different varieties of wheat.

2.2.2.7 Iron

Davis et al ., (1984) found 1.2 to 7.4 mg/100gm of iron content in different samples of wheat flour. **Narayan (1991)** observed 3.05 mg/100g iron content in refined flour. **Bourne (1989)** reported iron content 3.33 and 2.8 mg/100g in 95 and 91 percent extraction wheat flour, respectively. **Rawat et al., (1994)** and **Dogra et al., (2004)** observed 2.6 (mg/100g) and 5.90 (mg/100g) of iron in wheat flour, respectively.

2.2.2.8 Crude Fiber

Diwan et al., (1982), Shekara and Shurpalkar et al.,(1984), Singh et al.,(1989), Rawat et al., (1994), Rao (1995), Dubey et al.,(2002), Sharma and Chauhan (2002) reported a range 0.6 to 0.7 percent crude fibre in commercial soft wheat flour. **Gonzallez- Galan et al., (1994), Dogra et al., (2004), Ballester et al.,(2004)** reported

lower range (0.40 to 0.45 percent) of crude fibre than the above range. **Rana (2006)** also reported 0.50 percent crude fibre in wheat flour (Maida). **Mishra et al.,(1994)** reported 0.25% and 0.35% crude fiber in UP-319 and RR-21 variety respectively which was lower than the above value.

2.2.2.9 Carbohydrate

Carbohydrate content ranged 73.5 to 75.5 percent in wheat flour as reported by **Onwelleuzo and Iwezu (1998)** and **Dubey et al (2002). Tara et al., (1969)** and **Julie Dogra et al (2004)** reported slightly lower values 72.5 and 73.06 percent of carbohydrate content respectively. According to **Diwan et al., (1982)** and **Shekara** and **Shurpalakaur (1984), Suresh (1995)** the carbohydrate content ranged from 82.24 to 89.2 percent. The values (84.4 percent) reported by **Rawat et al., (1994)** were in close conformity of the above range.

2.2.2.10 Rheological characteristics of wheat flour

It has long been established that the rheological properties and bread making performance of wheat flour are related to the quantity and quality of their proteins **(Finney and Barmore., 1948)**.

Gupta and Pingale (1970) evaluated the chemical characteristics of some high yielding wheat varieties. The sedimentation values ranged from 18 to 33. The alcoholic acidity was found well within limits ranging from 0.05 to 0.08 percent expressed as percentage of H_2SO_4. The silicious matter in these varieties as indicated from acid

insoluble ash was found satisfactory in the range of 0.1 to 2.0 percent. The SDS sedimentation test revealed significant effects of black gram flour (BGF) on flour properties as evident from the decreases in values by 16, 12, and 17 ml when 25 percent of wheat flour was substituted by untreated, roasted, and germinated BGFs respectively **(Patel and Rao, 1995)**. The sedimentation values of seven wheat varieties ranged from 25 to 44 ml. Minimum (25ml) was in HD-2687 and maximum (44ml) in C-306. Based on these values, the varieties could be classified into soft wheats with sedimentation values between 30 and 40 ml. Accordingly Sonalika, HD-2329, HD-2687, and HD-2009 could be grouped under soft wheats which are good for the preparation of cakes and biscuits. Sonak, PBW-342, UP-2338, WH-283, WH-291, WH-542, and Raj-3765 are medium varieties and could be considered as all purpose flours **(Shingh et al., 2006)**. Almost similar variations in sedimentation values have been shown by **Nema et al. (1989), Singh et al. (1990)** and **Prablashankar et al (2000).**

Oladunmoye et al., (2004) studies on characterization of rheological properties of wheat and non wheat based doughs intended for breadmaking. Dough samples (with and without yeast) were prepared separately from wheat, cassava and maize flours, wheat-cassava and wheat maize flour blends at 0,40, 50, 60 and 100% levels of wheat substitution .Each sample was tested for pasting characteristics and creep-compliance recovery to determine their suitability for breadmaking. Amylograph pasting temperature ranged between 57.9 and 67.2^{0}C among the samples. Peak viscosities of the dough increased with increasing levels of wheat substitution with cassava and maize flours, while changes in the stability set back volume and consistency depended on the type and

level of non-wheat flour. Creep-compliance rheological data for yeasted dough had similar values of instantaneous elastic compliance 1.20×10^6 and shear modulus 9.64×10^6 / Pa showing that wheat cassava (at 60%) and wheat maize composites (at 40%) would yield breads comparable to wheat bread with in the limits of rheological predictions.

The effect of gamma irradiation on some biochemical, rheological and functional properties of bread wheat. Two wheat cultivars were selected to represent medium-strong and weak dough mixing strengths. Falling numbers values were severely depressed at doses of 500 and 1000 krad. Rheological dough properties , as assessed with the mixograph and farinograph, were also investigated Radiation at medium doses produced on increase in the farinograph water absorption for both wheats radiation decreased the amount of bound water as compared to the control sample reported by **Paredes-Lopez et al., (1984).**

Sharma and Chauhan (2000) reported on physical, sensory and chemical characteristics of wheat bread supplemented with fenugreek (*Trigpnella foenum. graceum*). The addition of fenugreek (*Trigpnella foenum graceumL.*) to wheat flour increased the baking absorption of wheat flour without exhibiting a loaf volume depression effect up to 3% level and gave a satisfactory loaf volume up to 7.5% level of substitution. However, at 9% level fenugreek flavour dominated in the loaf. Addition of fenugreek to bread flour at 7.5% level not are increased the protein, available lysine and

dietary fibre contents. But also gave product of acceptable quality as judged by sensory evaluation studies.

2.3 BARLEY

Barley (*Hordeum Vulgare L.*) is one of the founder crops of old world agriculture. Barley has been used as food for man since antiquity. Barley is resilient plant, tolerant of a range of conditions, which may have been cultivated since 15000 BC **(Fast & Caldweel 2000).** Cultivated barley *Hordeum Vulgare,* is mainly grown for animal feed, especially for pigs, for malting and brewing in the manufacture of beer and for distilling in whisky manufacture. A small amount of barley is used for food. Pearled barley is eaten in soups and stews in the UK and in the far and middle East; Barley is also used in bread (as flour) and ground as porridge in some countries **(Kent & Evers 1994).** Barley grain based feeds are used on pig and cattle farms. Barley is a valuable grain for finishing beef cattle in the united states and is also used in swine diets particularly in geographic regions where maize cannot be economically produced, thus it competes with wheat as a feed in the those climates **(Mahdi et al. 2008)**. The use of barley for food consumption is shown in Table 2.3.

It is estimated that about 85 % of the world's barley production is destined for feeding animals, while the rest is used for malt production, seed production and food consumption but also for production of starch either for food use or for the chemical industry. Some 140 million tones of barley is produced annually worldwide.

Table no- 2.3 Use of barley for food consumption in 2002

Country	Consumption	Share in total food consumption
Algeria	480	6.7
China	661	9.2
Ethiopia	887	12.3
Germany	170	2.4
India	1108	15.4
Republic of Korea	220	3.1
Morocco	1071	14.9
Poland	205	2.8
Ukriane	161	2.8
USA	149	2.0
Total	7207	100.0

Source : Dr. Ghanim Salih Mahdi et al (2008)

Table 2.4 All India State Wise Area Coverage and Yield Estimate of Soybean During Kharif 2006

Name of the State	2004 Kharif			2005 Kharif			2006 Kharif		
	Area sown	Yield in Kg. per ha.	Total Production in lakh MT	Area sown	Yield in Kg. per ha.	Total Production in lakh MT	Area sown	Yield in Kg. per ha.	Total Production in lakh MT
Madhya Pradesh	44.439	824	36.596	41.92	796	33.351	46.03	91%	41.745
Maharastra	18.717	928	17.377	23.89	822	19.635	23.89	84%	20.083
Rajasthan	5.563	775	4.31	6.981	704	4.913	7.471	60%	4.482
Andhra Pradesh	0.69	983	0.678	1.359	965	1.311	1.359	41%	0.56
Karnatka	1.775	880	1.562	1.418	850	1.21	1.65	87%	1.44
Chattigarh	0.4	815	0.326	0.65	750	0.488	1.15	68%	0.78
Rest of India	0.5	742	0.371	0.5	725	0.363	0.5	60%	0.3
G.Total	72.083	849	61.22	76.72	799	61.266	82.05	85%	69.391

Source: Soy Update (Aug. 2006)

In industrialized countries the consumption of barley as food has lost most of its earlier importance in human nutrition. The largest use is in fermented bakery products. Malt extract is a source of soluble sugar, protein and amylases in loaf volume, good flavour and colour to the finished bakery products. Further applications of malt products are for non- fermented bakery product, for example, crackers, cookies and muffins. Malted barley rich in enzymes is also used for bakery product as a source of amylases to compensate the low a-amylase activity in bread wheat flours (**Mahdi et al 2008**).

The barley head or spike is made up of spike lets, which are attached to the rachis in an alternating pattern. The outer layer of the barley kernel consists of a husk, completely covering the grain; the pericarp (to which the husk is tightly joined in most species); the testa or seed coat and the aleurone **(Brigid MC Kevith 2004).**

2.3.1 Barley Flour

Most commercial barley flour is made through a malting process. Malted barley flour uses whole barley which is allowed to sprout and then rapidly dry. Malting changes the chemical structure of the barley slightly, and it is also the first step in brewing. It is also possible to find unmalted barley flour, or you can make barley flour at home, if you have a grain mill. Pearled or hulled barley can both be used, although malted barley flour has higher nutritional value since it includes the rich hull of the grain. Like other flours, barley flour can go rancid. It can be stored in a cool dry cupboard for one to two months, or in a freezer for three to four months. When barley flour is kept in the freezer, cooks can measure out the amount that they need to warm to room temperature and put the rest

back in the freezer. Barley flour has weaker gluten than wheat flour, so baked goods may turn strangely if too much barley flour is used (htt.//www.wisegeen.com).

Barley nutrients are not limited to vitamins and minerals, but the value of barley nutrition to human health varies depending on the type of barley that is consumed. How it is processed and even where it is grown. The large number of nutrients in barley grass, particularly protein, explains its popular use as animal feed. Some health supplement manufactures advise that the nutrients in barley grass are important to human health. Since ancient time, however, humans have collected and eaten hulled barley grains. Hulled barley, per cup include 22 grams of protein, 61 mg of calcium, 245 mg of magnesium, 486 mg of phosphorus, 832 mg of potassium and 69 mcg of selenium. It is also a good source of lutein and zeaxanthin as well as other vitamin and amino acids.

Anjum M et al., (1990) reported Fatty acids, mineral composition and functional (bread and chapati) properties of high protein and high lysine barley lines. Six barley lines derived from corsses involving Hiproly (SV 73608×Mona5) and Riso 1508 with higher yield recipients V 43-42 and V 5681, along with the four parents, were analyzed for fatty acids and mineral composition. Dough properties, bread and chapatties were characterized by blending barley line (B82503) at 2.5-25% with bread wheat flour (pak 81). Fatty acid contents were myristic acid, 0.60-1.16%; palmitic acid, 16.68-20.84%; stearic acid, 1.30-3.33% and degree of unsaturation 1.40-1.50%. The derived lines contained similar amounts of essential fatty acids. Significant variation for magnesium, copper, zinc, phosphorus and potassium was observed but overlapped among

the lines and parents. The calcium, iron, and manganese showed non-significant differences among lines and parents.

Cooked pearled barley nutrient content, per 100 gm, includes only 2.39 percent of protein, 11.48 mg/100gm of calcium, 23.6 mg/100gm of magnesium, 57.4 mg/100gm of phosphorus, 98.6 mg/100gm of potassium and 8.78 mcg/ 100gm of selenium. Pearled barley nutrients are so much lower than those found in hulled barley, because the bran and germ have been removed reported by **Cantwell (2007).** Barley is a food known for its higher fiber content- ranging from 15.3% to 31.6 % compared with 9.6 % in whole meal wheat flour. Although the fibre content, together with all other nutrients, except chromium, in the barley grain are significantly reduced in the milling process of barley into flour-primarily due to the decortication processes , even dehusked (pearl) barley contains appreciably more fiber- 5.9 % compared with white wheat flour- 3.7 % **(Mahdi et al., 2008)** .

2.3.2 Composition of Barley Flour

2.3.2.1 Moisture

USDA National Nutrient Databased for Standard Reference (2006) reported 12.11 gram water per 100 gm barley flour or meal.

2.3.2.2 Fat

Ereifej, et al.,(2006) reported a range from 1.6 to 5.0 percent fat content in different varieties of barley flour. **USDA National Nutrient Database for Standard Reference (2006)** reported 1.60 (gm) per 100gm fat content in barley flour or barley

meal. **Grausgruber et al.,(2004)** observed the total fat content 2.26, 2.20 and 2.07 gm in barley hull-less, hulled and hulled black, respectively which is in the above range.

2.3.2.3 Protein

The value of protein content in hulled barley reported by **Cantwell (2007)** was 14.86 percent. **USDA National Nutrient Database for Standard Reference (2006)** reported lower value (10.50 percent) of protein content in barley flour or meal. **Grausgruber et al .,(2004)** analyzed hull-less, hulled and hulled black whole grain flour (%db) and found crude protein content 17.76, 15.05 and 18.83 percent, respectively. **Ereifej, et al., (2006)** reported a range of 11.2 to 16.2 percent protein in different varieties of barley flour.

2.3.2.4Amino Acid

Macrae et al., (1993) analyzed amino acid in barley flour and reported phenylalanine (5.2gm /100gm), Histidine (2.1 gm/100gm), Isoleucine (3.6 gm/100gm), Leucine (6.6 gm/100gm), Lysine (3.5 gm/100gm), Methionine (2.2 gm/100gm), Threonine (3.2 gm/100gm), Tryptophane (1.5gm/100gm) and Valine (5.0 gm/100gm) .

2.3.2.5 Total Ash

Ereifej et al.,(2006) reported a range of 0.5 to 4.7 percent ash in different varieties of barley flour. **USDA National Nutrient Database for Standard Reference (2006)** reported 1.28 gm ash content per 100 gm barley flour or meal which is in the above range. **Grausgruber et al.,(2004)** evaluated three different sample of barley (hull-

less, hulled and hulled black) were found 2.06, 2.44 and 2.54 percent ash content, respectively.

2.3.2.6 Calcium

USDA National Nutrient Database for Standard Reference (2006) reported 32.0 mg/100gm calcium in barley flour. However, **Cantwell (2007)** reported 41.21 mg/100gm of calcium in barley flour.

2.3.2.7 Phosphorus

USDA National Nutrient Database for Standard Reference (2006) reported 296.0 mg per 100 gm phosphorus content in barley flour or meal. However, **Cantwell (2007)** reported 328 mg per 100gm of phosphorus in hulled barley which is higher than the values reported earlier.

2.3.2.8 Iron

According to **USDA National Nutrient Database for Standard Reference (2006)** 2.680 mg/100g of iron content was found in barley flour and meal.

2.3.2.9 Crude Fiber

Ereifej et al., (2006) reported 0.4 to 9.5 percent fiber in different varieties of barley flour. **USDA National Nutrient Database for Standard Reference (2006)** reported higher values (10.10 gm per 100 gm) of total dietary fiber in barley flour or

meal. **Grausgruber et al.,(2004)** reported 1.88, 4.02 and 5.20 (%db) crude fiber in hull-less barley, hulled barley and hulled black barley, respectively.

2.3.2.10 Carbohydrate

The values for carbohydrate content ranged from 68.6 to 86.4 percent in different varieties of barley flour **(Ereifej et al., 2006). USDA National Nutrient Database for Standard Reference (2006)** observed the value (74.52 gm per 100gm) in the same range of carbohydrate in barley flour and meal.

2.4 DEFATTED SOYBEAN

Soybean *(Glycine max)* is a major oil seed crop in India next to groundnut (*Arachis hypogaca L*). Soybean is one of the nature's wonderful nutritional gifts. Soybeans were introduced in India during mid sixties; information on quality characteristics of Indian varieties is limited. A number of soybean varieties have been developed by the plant breeders in the country during the past few years and a few varieties have been studied for their chemical composition and cooking characteristics **(Smita and Vaishali 1989; Om Kumar et al 1992).** It is one of the very few plants that provide a complete protein source and it has high quality protein with minimum saturated fat. Soybean helps people feel better & live longer with an enhanced quality of life. Soybeans contain all three of macronutrients required for good nutrition's: complete protein, carbohydrate and fat, as well as vitamins and minerals, including folic acid, calcium, potassium and iron. Soybean is the only plant that contains complete protein soybean protein provides eight amino acids in the amounts needed for human health. The

amino acid pattern of soy protein is virtually equivalent in quality to that of meat, milk and egg protein. Soybeans are most valued nutritionally for their unsaturated fatty acids, protein and fiber content.

Soybeans are a native crop of eastern Asia where they have served as an important part of the diet for centuries. Soybeans are an excellent source of protein and fat which justifies their consumption as a food. Because of their high protein and fat content soybean crop is steadily gaining popularity in India in recent years. At present a major portion of soybean crop in the world, is being used for oil extraction. However, attempts are also being made to utilize soybean for manufacturing various food products **(Smith and Circle, 1978).** India produces about 2.3 million tonnes of soybean which is about 2% of the total world soybean production **(Nawab ali 1993).** It is leguminous plant the soybean is extensively consumed in Japan China & has increasingly grown in the united state **(Anita et al., 2000, Shrilakshmi 2001).** All India state wise area coverage and yield estimate of soybean during Kharif shown in Table- 2.4.

2.4.1 Defatted Soy Flour

Soy flour and grits are the simplest of edible soybean protein products. The Annual production of edible soybean flour and grits increased from some 60,000 tons in 1960 to about 2,000,000 tons today. Soy flour is a product obtained by finely grinding full-fat dehulled soybeans or defatted flakes made from dehulled soybeans. To be called soy flour, at least 97% of the products pass through a 100-mesh standard screen.

Soy grits have essentially the same composition as flour, but coarser granulation. They are usually classified into three groups, according to particle size as coarse 10 to 20 mesh, medium 20 to 40 mesh, fine 40 to 80 mesh.

Edible soy flours are made from dehulled beans, hence their relatively low crude fibre and high protein content.

Soy flours (or grits) are classified according to their lipid content as follows:

* **Defatted soy flour,** obtained from solvent extracted flakes, contains less than 1% oil.

* **Full-fat soy flour**, made from unextracted, dehulled beans, contains about 18% to 20% oil.

* **Low fat soy flour,** made by adding back some oil to defatted soy flour. Lipid content varies according to specifications, usually between 4.5% and 9%.The most common range is between 5% and 6%.

* **High fat soy flour,** produced by adding back soybean oil to defatted flour, usually at the level of 15%.

* **Lecithinated soy flour**, made by adding soybean lecithin to defatted, low fat or high fat soy flours in order to increase their dispersibility and impart emulsifying properties.. Lecithin content varies according to specifications, usually up to 15%

The whole dry grain contains about 40% protein and also upto 20% fat **(Srilakshmi 2001)**. As per the American Journal of Clinical Nutrition, "it can be concluded that soy protein can serve as a sole protein source in all human beings except premature infants".**(Mindell Earl, 1995)**. Soybean contains 21% carbohydrate and provides 432 Kcal (1.8MJ) per 100gm **(Anita, et al., 2000)**. **American Soybean Association (2000)** claimed that protein content in soy is about 3 times more then any variety of dhal. Protein in just

250grams of soybean is equivalent to protein in 3 liters of milk or one kg of mutton or 24no's of egg. The composition of soybean is given in Table 2.5. Commercial soybeans constitute approximately 8.0 percent hull, 90 percent cotyledon and 2 percent hypocotyls and plumule. Proximate composition for whole beans and three fraction given in Table 2.6. The constituents of major interest- oil and protein make up about 60 percent of the beans but about one third consists of carbohydrates including polysaccharides, starchyose (3.8 percent) raffinose (1.1 percent) and sucrose (5 percent).

Dogra J, et al (2001) studied effect of soaking, germination, heating and roasting on the chemical composition and nutritional quality of soybean and its utilization in various Indian leavened products. Soybeans obtained from variety " green" were cleaned, soaked (12h), germinated (48 and 96h), heated (80^0 C for 15 min) and roasted (20min) before converting into flour fineness. Protein and fat contents were found to increase with germination of soybeans. Heat treatment given to soaked and soaked and germinated (48 and 96h) samples increased the content of the nutrients, while roasting of soybeans slightly decreased the protein and fat contents. Free fatty acids, free amino acids, the total carbohydrates and starch contents decreased with different treatments. Diastase and protease activities increased with increases in germination period. Trypsin inhibitor activity was reduced with soaking, germination and heating of soybeans. Supplementation of wheat flour with soybean flours upto 15% was acceptable for making acceptable quality Nann and Kultche. The higher levels of soybean were acceptable for making gulgulae (upto 20%), bhuturu (upto 30%) and babru (upto30%). The heat

treatment given to soaked, soaked and germinated (48 and 90h) soybeans further improved the acceptability of the products.

Saxena S et al (1994) Studied that physical characteristics and composition of certain new varieties of soybean. The six varieties of soybean showed 7.3-8.6% hull, 0.69-074 g/cc bulk density, 1.05 –1.18 g/cc true density, 94.3 –145.6 gm 1000 grain weight and 5.6 – 7.6 kg hardness in vertical position and 13.0-19.8 kg in horizontal position. Colour of varieties ranged from light yellow to golden yellow.

2.4.2 Composition of Defatted Soy Flour

2.4.2.1 Moisture

Shrestha k A et al (2001) reported 8.20 and 6.62 percent moisture content in LFSF and FFSF, respectively. **Circle** and **Smith (1972)** and **Clyde E- Staffer (2006)** reported 7.0 and 8.0 percent moisture content in defatted soy flour, respectively. **Gupta et al., (2006)** reported lower value (5.0 percent) moisture content in defatted soy flour.

2.4.2.2 Fat

Some of the reported values for percent fat from India on dry weight basis were 18.6 **(Kenneth et al., 1991),** 19.5 **(Gopalan C, et al., 1991)**, 21 **(Anita et al., 2000)**, 20 **(Srilakshmi 2001)**. The values of fat content reported by **Saxena et al.,(1994)** from 16.5 to 18.3 percent in different varieties of soybean. **Shrestha et al., (2001)** reported 6.70 and 21.85 percent fat in LFSF and FFSF, respectively. **Gupta (2006), Circle and Smith (1972)** reported fat content in defatted soy flour was 0.90 percent. **The Department of**

Agriculture Human Nutrition Information Service, Agriculture Hand Book (1986) reported value (1.20 percent) of fat in defatted soy flour. **Rawat et al., (1994)** reported lower value (0.70 percent) fat content in defatted soy flour. Soybean is attractive nutritionally high protein content of good quality and over 50% of the fat is in the form of polyunsaturated fatty acid (PUFA) **(Arnold & Choudbury, 1962).**

2.4.2.3 Protein

Soybean contains 43% protein, which is higher than in other protein rich foods including meat and fish, which contain about 20%. The protein content in soybean ranges from 28.52 to 43.56 percent **(Anita et al 2000). Saxena et al.,(1994)** reported a range from 34.3 to 40.7 percent protein in different varieties of soybean. **Kenneth et al., (1991), Gopalan et al., (1991), and Srilakshmi (2001).**, reported the value of protein content in the same range. **Shrestha et al (2001)** reported 51.68 and 44.08 percent protein content in LFSF and FFSF, respectively. **Department of Agriculture Human Nutrition Information Service, Agriculture Hand Book (1986)** reported 47.0 percent protein content in defatted soy flour. **Circle** and **Smith (1972), Clyde E. Stauffer (2006)** and **Gupta (2006)** also reported 59, 50 and 53 percent of protein content in defatted soy flour, respectively.

2.4.2.4 Total Ash

The ash content in defatted soy flour was 6.4 percent reported by **Circle and Smith (1972). Rawat et al., (1994)** and **Gupta (2006)** reported values 6.0 and 7.4

percent ash content in defatted soy flour, respectively. **Shresth et al., (2001)** reported 5.44 and 4.73 percent ash content in LFSF and FFSF, respectively.

2.4.2.5 Calcium

Saxena et al., (1994) reported a range from 247.4 to 307.7 mg/100gm calcium content in different varieties of soybean. **Mishra et al.,(1991)** reported 280 mg/100gm calcium content in defatted soy flour. The value of calcium content in defatted soy flour was reported 241 mg/100gm (**Department of Agricultural Human Nutrition Information service, Agriculture Hand Book (1986).**

2.4.2.6 Phosphorus

Saxena et al., (1994) reported a range from 491.1 to 540.9 mg/100gm phosphorus content in different varieties of soybean. **Mishra et al.,(1991)** and **Rawat et al., (1994)** reported higher values 650 mg/100gm and 698mg/100gm of phosphorus content in defatted soy flour, respectively.

2.4.2.7 Iron

The values reported by **Saxena et al., (1994)** ranged from 10.3-13.4 percent of iron content in different varieties of soybean. **Department of Agriculture Human Nutrition Information service, Agriculture Hand Book (1986)** showed little lower value (9.20 percent) in defatted soy flour. **Rawat et al., (1994)** reported higher value (16mg/100gm) of iron content in defatted soy flour.

2.4.2.8 Crude Fiber

The values of crude fiber content in soy flour reported by **Department of Agricultural Human Nutrition Information service, Agricultural Hand Book (1986)** was 4.30 percent in soy flour. **Circle and Smith (1972)** and **Rawat et al.,(1994)** reported lower value of crude fibre 2.6 percent and 3.4 percent in defatted soy flour, respectively. **Shrestha et al., (2001)** reported higher values of crude fibre (7.50 percent) in LFSF and (6.50 percent) in FFSF.

2.4.2.9 Carbohydrate

The carbohydrate content ranged from 20.0 to 25.4 percent in different varieties of soybean (**Saxena et al., 1994). Department of Agriculture Nutrition Information Service, Agriculture Hand Book (1986)** reported higher value (38.4 percent) of carbohydrate content in defatted soy flour. **Rawat et al., (1994)** reported 31.4 percent of carbohydrate content in defatted soy flour.

2.5 FOOD USES OF BARLEY AND SOYBEAN

Flour produced from whole barley is much more nutritious than flour ground from pearled barley because the bran is left intact. Barley flour is a fine powder made by grinding whole grain. Along with many other flours, it can be used to replace part of the wheat flour in a recipe for, a different flavour and texture. Barley flour also is used in

other cooking applications, such as acting as a thickener in soups and sauces. Many natural foods stores carry barley flour, and it can also be made at home.

Bread flour is high-gluten flour that has very small amounts of malted barley flour and vitamin C or potassium bromate added. The barley flour helps the yeast work, and the other additive increases the elasticity of the gluten and its ability to retain gas as the dough rises and bakes. All- purpose flour is made from a blend of high and low- gluten wheats, and has a bit less protein than bread flour- 11% or 12% Vs 13% or 14%. It is especially useful as a component in rye, barley and other mixed- grain breads, where the added lift of the bread flour is necessary to boost the other grains (htt/www.ochef.com). Pearled or hulled barley can both used; with although malted barley flour has a higher nutritional value since it includes the rich hull of the grain (www.wisegeen.com).

Blending up to 10% barley flour with bread wheat flour gave farinograph characteristics comparable to those of pure wheat flour, but increasing the proportion of barley beyond this decreased the mix time and dough stability. Bread baking tests verified that up to 10% barley could be mixed with wheat without adversely affecting loaf volume and other quality attributes. For chapatti making up to 20% barley could be blended into the wheat, yet yield acceptable quality.

Table no : 2.5 Composition of soybean is given in per 100gm.

Composition	Percentage
Energy	43.2 Kcal
Protein	43.2 gm.
Fat	19.5 gm
Carbohydrate	20.9gm
Calcium	240 gm
Iron	10.4gm
Carotene	426 mg
Thiamine	73 gm
Riboflavin	3.2 mg
Niacin	3.2 mg

Source: (Gopalan C; et al 1991)

Table no :2.6 Proximate composition and seed parts:

Fraction	Protein (N x 6.25) (%)	Fat (%)	Ash (%)	Carbohydrate (%)
Whole bean	40.0	21.0	4.9	34.0
Cotyledon	43.0	23.0	5.0	29.0
Hull	8.8	1.0	4.3	86.0
Hypocotyl	41.0	11.0	4.4	43.3

*Moisture free basis

(From kawamura, 1967)

Soybean is also directly as vegetable or dhal and in dairy or bakery products. The defatted soy flakes remaining after oil extraction are the basis of a variety of soy products including soy flour, soy concentrates and soy isolates. Defatted soy flours are about 86% protein and have very little moisture. They contain no fiber, carbohydrates or fat. Soy isolates are the chief component of many dairy-like products, including cheese, soy milk, infant formula, non-dairy frozen desserts and coffee whiteners. They are used to add texture to meat products and are valued for their emulsifying properties. Soy concentrates contain about 65% protein and retain most of the bean's dietary fibre. Concentrates also add texture and help food retain moisture (**Suresh Itapu, 2003**).

2.5.1 Soy Fibre

Soybeans, especially the outer hull, are an excellent source of dietary fibre (6 grams fibre per 1 cup cooked). When soybeans are processed, the hull is removed and then processed further to create a fibre additive for breads, cereals and snacks. Soybeans contain both soluble and insoluble fiber. Soluble fiber may help lower serum cholesterol and control blood sugar. Insoluble fibre increases stool bulk, may prevent colon cancer and can help relieve symptoms of some digestive disorder **(Suresh Itapu 2003)**.

2.5.2 Soy Flour

The main function of soy flour in bread is protein fortification and gluten strength enhancement. It improves water binding capacity as well as crumb colour. For protein fortification any kind of soy flour (having acceptable flavours) will work. If it is desired to improve the strength and mixing tolerance of dough, then enzyme active flour should be used. Lipoxidase requires fat as substrate to carry out its action, so if you are using a

low fat bread formula, you must use 0.5 to 1% full fat enzyme active flour. If formula contains around 3% shortening then same level of defatted enzyme active flour will do the job. For fortification, 5-10% of defatted soy flour should be used **(Suresh Itapu 2003)**. The PDI is 70 or more, the soluble protein will hold water in the loaf during baking, giving moister bread with slow staling rates. Toasted soy flour (PDI around 20) gives a nice nutty flavour to bread.

Addition of soy flour in bread improves the amino acid balance in the protein. Small amount of soy flour (1-2%) is needed to provide all the lysine and methionine plus cysteine needed for an adult. Levels of soy flour above 8% create a need for oxidation in the dough. About 100 pm ascorbic acid can be added to meet the requirement. About 0.5% of enzymes active soy flour will make flour more tolerance to moderate over mixing and also improving the loaf volume. Soy flour can also act as a replacer of no fat dry milk (NFDM). A common milk replacer can be formulated with defatted soy flour (with PDI 70 or more mixed with sweet whey powder **(Suresh Itapu 2003).** Selection of soy flour for bakery products soy flour is not just one ingredient but is made up of several components which have different kind of functions. In addition these functions differed according to the type of soy flour used. The best method is to understand the functionalities of different kinds of Soy flour, then choose the variety of Soy flour, which gives that property. Soy flour may do many different things in bakery foods. On the other hand, only the soluble protein is active in emulsification (as in cake batters) or in holding water to give a moisture final baked product. Lecithin helps in emulsifying fat in a dough or batter and is also helps.

2.6 THERAPEUTIC VALUE OF BARLEY FLOUR AND SOY FLOUR

Whole barley flour is considered an excellent ingredient for providing soluble fiber, which help to reduce cholesterol in the blood. Barley flour provides nearly as many nutrients as hulled barley and will improve the nutritional value of baked goods when used as a substitute for all or part of the wheat flour. Barley also includes beta-glucan content, a form of soluble fiber. The cholesterol lower effects achieved by consuming oats and products that contain oats are believed to be related to beta- glucans. Barley is even higher in beta-glucans than oats. Both barley nutrition content and oat nutrition content are higher than that of wheat or rye **Russell Cantwell (2007).**

Soybean being rich in proteins and energy has a great potential to solve the problem of protein energy malnutrition in India and many other developing countries. One way of utilizing soybean as food is fermentation **(Khader 1983)**. The processed foods from soybean in India are relatively low. The supplementation of cereal –based diets with soybean can play an important role in combating the protein energy malnutrition. Soybean being rich in nutrients, its acceptability as raw food is limited due to the presence of anti-nutritional factor such as, trypsin –inhibitor, saponins, haemoag-glutinins, beany flavour, bitterness and poor digestibility **(Liener 1981).**

Soy proteins have long been known to have excellent nutritional value. The more recent news is that soybean and soy products are being studied as to their capacity to prevent and treat chronic diseases such as cancer, atherocsclerosis **(Caragay, 1992;**

Messaina M and V. Messina 1994;) Hypercholesterolemia **(Carroll, 1991; Sirtori et al 1993).** Menopause symptoms **(Cassidy et al., 1994)** and Osteoporosis **(Anderson et al., 1997)**.

2.6.1 Cancer

Lee and Co-workers (1991) point to an important link between soy consumption and a reduce risk of certain types of cancer. Several studies suggest that the high intake of soy protein protects from development of breast cancer **(Messina et al., 1994).** These soy protein sources of soy isoflavones, which may protect from development of breast cancer **(Messina MJ et al., 1994; Lamartiniere et al ., 1984; Setchell et al., 1984; Peterson et al., 1991)**. The U.S. National Cancer Institutes five year "Designer foods" initiative has recently enlisted soybean as one of the six most promising foods in cancer prevention **(Caregay, 1992).** Of the fourteen major phytochemicals in foods soybean contain seven, including phytates, flavanoids, carotenoids, coumarins, triterpenes, lignans and phenolic acid **(liu et al., 1995)**. Iso- flavones are plant chemicals unique to soybean, which have important chemical properties. These compounds inhibit a number of enzyme reactions and act as antioxidants. They have actions that resemble the potent antiestrogen tamoxifen **(Setchell, 1984).** Genistein, a major soy isoflavone, also inhibits growth of a number of cancer cells in laboratory tests **(Messina et al., 1994; Barnes et al ., 1990; Lamartiniere 1995; Broihier, 1997).**

2.6.2 Cholesterol and Heart diseases

Besides being a healthy nutrition for the general mass, soy protein in a proven cholesterol- lowering agent **(Carrol, 1991).** Studies conducted over the past several years

shown that soy protein is hypo-cholesterolemic. Many studies have found that adding soy protein to the diet or replacing animal protein in the diet with soy lower blood cholesterol **(Carol, 1991; Sirtori et al., 1993)**. The cholesterol lowering effect of soy has been attributed to isoflavones a class of phytochemical founds in soybean **(Potter, 1998)**. According to **Anderson (1995),** every one percent reduction in cholesterol values is associated with an approximate 2-3% reduction in the risk of coronary heart disease. Based on results observed in different studies, it can be assumed that a daily intake of 20-50gm of isolate soy protein could result in a 20-30% reduction in heart disease risk **(Potter et al., 1993; Bakhit et al., 1994; Widhalm et al., 1993).**

2.6.3 Osteoporosis

Osteoporosis causes bones to become porous and brittle from the loss of calcium and other minerals. It progresses without any symptom that is until irreversible pain, loss of height and bone fractures occur. Soy foods may play other roles in protecting bone health **(Anderson et al., 1997).**

2.6.4 Other Health Benefits

A variety of soy products are available in the market with different flavours and textures, and a low fat, nutritionally balanced diet can be developed from them. These soy- based diets can help to control weight by providing high quality protein in a concentrated form and can be meat in specifically designed low –calorie/ high-nutrient, ready to eat meals **(Soy Protein Council, 1987).**

2.7 ANTI-NUTRITIONAL FACTOR

Soybeans contain many anti-nutritional factors like trypsin inhibitors, hemagglutinins, goitrogens, saponins etc. undesirable flavour has also been found to develop when raw soybeans are ground. These two aspects are associated with limited utilization of soy foods in India. Some of these anti-nutritional factors are heat stable while others are heat labile (Table 2.7).

Table no . 2.7 Anti-nutritional factors in soybean*

Heat labile	Heat stable
Trypsin inhibitors	Saponins
Hemagglutinins	Estrogens
Goitrogens	Flatulenece Factor
Anti vitamins	Lysino-alanine
Phytates	Allergens

Source- *(Liener, 1981)

2.7.1 Trypsin Inhibitors

It is probably the most studied anti-nutritional factor of soybeans. It inhibits a number of proteolytic enzymes among which trypsin are most important. **Osbrone** and **Mendal (1917)** were probably the first to report that heating of soybeans supported better growth of rats. Later on **Read** and **Haas (1938)** reported that an aqueous extract of soy flour inhibited the ability to liquify gelatin due to the presence of an inhibitor of trypsin. **Kunits (1947)** showed that the inhibition of trypsin by crystalline soybean trypsin inhibitor was directly proportional to the amount of inhibitor neutralized approximately an equal weight of crystalline trypsin. This inhibitor was shown to consist of five or six forms **(Birk et al.,**

1963). Inhibitor activity varied with the variety of soybeans **(Horii and Miyazaki,1973; Roy and Bhat, 1974).**

Trypsin inhibitor was thought to inhibit digestion of dietary protein by protolytic enzymes of the intestinal tract of experimental animals **(Liener, 1978).** However, earlier work of **Desikachar and De (1947)** has shown that the preparations of soybeans inhibited growth even when incorporated into diets containing pre-digested proteins or free amino acids. This clearly showed that inhibition of proteolytic enzyme was not the sole factor responsible for poor growth.

Lyman and Lepkovsky (1957) explained the activity of trypsin inhibitor on the basis of hypertrophy of pancrease caused by soybeans. This caused excessive secretion of trypsin and chymotrypsin which resulted in considerable endogenous loss of essential amino acids. **Liener (1981)** accepted this explanation but reported that even the above factor is responsible for only 40 percent of the total growth inhibition caused by raw soybeans. He pointed out that undenaturated soybean protein is refractory to enzymatic attack unless denatured by heat. According to him this undenatured protein is also capable of binding trypsin. All the above works have been done on experimental animals but according to **Liener (1981)** physiological effects of trypsin inhibitor on human trypsin is only weakly inhibited by trypsin inhibitor and human pancrease is probably insensitive to hypertrophic effect of trypsin inhibitors.

Simon and Melnick (1950) reported that complete inactivation of trypsin inhibitor is not necessary .They found only 58 percent inactivation to be optimum. But **Rackis et al (1975)** found that no pancreatic hypertrophy occurred in rats fed on soy flour in which only 54 percent of trypsin inhibitor activity was destroyed and maximal PER corresponded to a destruction of only 80 percent of the inhibitor activity of soybean. **Krishnamurthy et al. (1958)** showed that steaming for 60 min completely destroyed the inhibitor in duhulled beans having 31.3 percent or 60.4 percent moisture. **Rambannd (1970)** observed steaming for 50 min of beans having 20 percent moisture to be sufficient as compared to 15 min reported by **Albrecht et al.,(1966)** for complete trypsin inhibitor destruction.

Time of inactivation for trypsin inhibitor has been reported to be affected by the moisture content of the beans, and method of heating or type of heating. In immersion cooking, time required for soybeans tempered to 60 percent moisture was found to be 5min as compared to 10min by steaming (Albrecht et al., 1966).This time was also much less than 10-15 min reported by **Mustakas (1971)** under almost identical conditions. Collins and Sanders (1976) reported that boiling of dehulled beans for 25 min inactivated 97-98 percent of extractable trypsin inhibitor activity. **Baker** and **Mustakas (1973)** found both hydrochloric acid and sodium hydroxide addition during immersion cooking to be ineffective in bringing about any appreciable change either in thermal sensitivity of trypsin inhibitor or NSI. **Antunes** and **Sgarbieri (1977)** reported boiling in water for 25min to be necessary to inactivate trypsin inhibitor in unsoaked soybeans.

Dry heating is less effective in inactivating the inhibitor as compared to moist heating or steaming. According to **Gallarodo et al.(1974)** subjecting beans to moist heat at 100^0C or 121^0C for 20 min completely inactivated the inhibitor while 1 hr was required by dry heating at 100^0C. Preliminary soaking followed by dry heat gave better results. Roasting whole soybeans at 206 to 234^0C for 15-24 sec. resulted in 75 to 90 percent destruction of trypsin inhibitor activity **(Jansen et al., 1978).**

Hamid et al. (1975) reported inactivation of trypsin inhibitors in soybeans by microwave heating for 3 min at 153^0C. **Manorama and Sarojini (1982)** studied the effect of different heat treatments in the trypsin inhibitor activity of soybean varieties. They reported that acid (boiling with tamarind at 100^0C for 30 min) and alkali treatment (boiling with sodium bi carbonated at 100^0C for 20 mini) were also effective in addition to pressure cooking for inactivation of trypsin inhibitor. A soybean line which lacks the kunitz trypsin inhibitor and produces better growth response has been discovered by **Orf and Hymowitz (1979).** It improves growth response but still falls short of heated soy flour. **Liener (1981)** indicated that thermal denaturation of the protein is necessary in order to achieve maximal digestibility of protein and hence a good growth response.

Tripathi et al., (2004) studied determination of thermal inactivation time for soybean trypsin inhibitor in different media. The thermal inactivation of trypsin inhibitor (TI) in raw soybean flour blended in distilled water, 2.5% brain and tomato sauce has been undertaken. The best-fit lines obtained by least square analysis showed maximum correlation coefficients (R^2). The values were 0.88, 0.84 and 0.85 for soybean flour

suspended is distilled water, brine and tomato sauce, respectively. In all the treatments, the survivor curves reflected a greater degree of reduction in trypsin inhibitor activity (TIA) ranging up to 92.9%. The thermal inactivation was found to the first order kinetics. In baked canned soybeans also the TIA was reduced up to 92.8%.

Soybean contains 40% protein and 20% oil and provide the most inexpensive source of high quality protein and oil. It is in use in various food products in oriental countries since many centuries and in India, it is becoming popular now. Soy foods are normal regarded as nutritious, cholesterol free health foods and play an important role in combating the protein calorie malnutrition. Trypsin inhibitor (TI) in raw soybeans causes growth depression, pancreatic hypertrophy, hyperplasia and adenoma in experimental animals (**Rackis 1965; Rackis 1965; Rackis 1974; yanatori and Fujita 1976; Rachis and Gubmann 1981**).

2.7.2 Hemagglutinin

Soybean extracts were found to possess the ability to agglutinate blood cells **(Jaffe, 1969).** This had been attributed to hemagglutinins which are present in raw flour to the extent of 3 percent **(Liener and Rose, 1953).** According to **Liener (1953),** hemagglutinin is responsible for about 50 percent of the growth inhibition of rate fed or raw soybeans. **Birk and Gertler (1961)** found them to be only partly responsible for the growth inhibition, since hemagglutinating activity was partially inactivated by gastric juices. Hemagglutinins have been shown to be sensitive to heat. They are readily destroyed by moist heat treatment **(Rackis, 1978, Liener ,1981).**

2.7.3 Goitrogens

Unheated soybeans have been reported to exert a goitrogenic effect in rats and chicks. This effect was counter acted by administration of iodine or partially eliminated by heating **(Blook et al., 1961).** The goitrogenic principles in soybeans have been reported to be low molecular weight oligopepties **(Konijn et al, 1972).** Goitrogenic activity has been detected to a lesser extent in toasted soy flours; soy protein concentrates and isolates **(Liener, 1981).**

2.7.4 Phytic acid

Soybeans contain 1 to 1.5 per cent phytic acid. This acid reduces availability of minerals such as calcium, zinc and iron **(Liener, 1981).** He suggested application of heat, enzymatic hydrolysis and ion exchange chromatographic separation as the possible means of eliminating phytic acid from soy based products.

2.7.5 Estrogens

A number of compounds capable of inducing an estrogenic response when fed to experimental animals have been identified in soybean **(Liener, 1981).** However, they interfere or inhibit growth only when soybeans are the sole constituent of the diet.

2.7.6 Saponins

They inhibit various enzymes including cholinesterase and chymotrypsin but their action is not specific **(Wolf and Cowan, 1975).** Whole soybeans contain about 0.5 percent saponins **(Smith and Circle, 1978).** Saponins were observed not to harm chicks, rats and mice even when fed of a level three times higher than the level in diets containing soy flour

(Ishaaya et al., 1969). Reviewing the anti-nutritional factors of soybeans in 1981, liner suggested removal of saponins from the list of anti-nutritional factors.

2.7.7 Flatulence factor

One of the important factors limiting the use of soybeans in the human diet is the flatulence associated with its consumption. **Rackis et al (1970)** found flatulence to be caused by oligosaccharides having alpha-galactosidic and beta-fructosidic linkages. **Rackis et al. (1970)** mentioned raffinose and stachyose to be more important. Flatulence is generally attributed to the fact that man is not endowed with enzyme (alpha-galactosidase) necessary for hydrolyzing the alpha galactosidic linkages of raffinose and stachyose to yield absorbable sugars. Consequently the intact oligosaccharides enter the lower intestine, where they are metabolized by the microflora producing gases **(Liener, 1981).** These components are soluble in water and can be removed by leaching with cold and hot water. **Silva and Braga (1982)** observed that cooking of whole beans in water led to greater removal of oligosaccharides as compared to soaking in cold water.

2.7.8 Allergenic principles

Soybeans contain certain allergenic principles which require more heating as compared to the major anti-nutritional factors **(Perlman, 1966).** As such a few cases of adverse reactions have been reported from heated soy products. Soybeans have been reported to possess immuno-chemical reactivity which was partially destroyed upon heating **(Liener, 1981).** Hence, most of the heat processed soy products do not cause any allergy and hypoallergenic.

2.7.9 Beany flavour and lipoxygenase

During processing of raw soybeans development of off flavour has been reported by many workers **(Mustakas et al., 1969; Nelson et al., 1971; Maga, 1973).** This flavour has been described as beany, painty, grassy, bitter or astringent. They are produced by the action of enzyme lipoxygenase upon lipids during processing of soybean under high moisture conditions **(Rathod and Williams,1972; Wolf, 1975).** Lipoxygenase, a dioxygenase that is widely distributed among plants catalyzes the addition of oxygen to a double bond of fatty acids. **Andre and Hou (1932)** were first to report about lipoxidase now referred to as lipoxygenase. They attributed the changes in the fat of unheated soybean to the presence of lipoxygenase.

Koch et al (1958) reported that soybeans contain two lipoxygenases one with a preference for triglycerides and the other one with a preference for free fatty acids. **Christopher et al (1972)** identified its three isoenzymes which differed from each other with respect to their optimum P^H, effect of calcium, stability to heat, iso-electric point and substrate specificity. Substrate for lipoxygenase may be straight chain fatty acids, esters, alcohols or even halides, which contain cis-cis, 1, 4 pentadiene structure. The most common substrates are the essential fatty acids, linolenic and arachidonic acid **(Eskin et al. 1977).** The optimum pH of enzyme has been found to vary with the substrate **(Koch et al.1958).** With sodium linoleate an optimum pH of about 9 was obtained while with methyl linoleate a pH of 6.5. This difference has been explained to be due to greater solubility of sodium linoleate at pH 9.0.

Grosch and Schwencke (1969) identified oct-2 enal, nona-2-4 dienal, deca-2, 4-dienal and pentanol as the major flavour compounds. **Drapon and Beausi (1969)** attributed beany flavour of bread fortified with soy flour to the presence of n-hexanol while the green beany flavour has been attributed by **Mattick and Hand (1969)** to the presence of ethyl vinyl ketone. **Wilken and Lin (1970)** identified 2-hexanal, ethyl vinyl ketone and 2-phentyl furan as compounds responsible for grassy bean odours. **Kalbrener et al.(1974)** indicated involvement of hydroperoxides of linoleic and linoleic acids in the origin of some of the flavours of soybean products. **Gardner (1975)** suggested that development of rancid off-flavours during storage of soybean products are due to non enzymic decomposition of lipid hydroperoxides. **Sosulski (1979)** reported phenolic compounds as important as unsaturated lipids in the development of adverse flavour in soybean products. Oxidized soy phosphatidyl choline (SPC) has been shown to be a bitter principle in soybeans **(Sessa et al., 1974)**.

Kinsella (1979) reported heated soy flour to develop a cooked repulsive off-flavour. Compound responsible for them was reported to be 4-vinyl phenol and 4-vinyl guaiacol. **Kalbrener et al.(1971) and Mage (1973)** reported that the typical raw soy flavour decreased with the application of heat. It also reduced the dispersibility of soy proteins. **Maga (1973)** also pointed out that sucrose, raffinose and stachyose present in soybeans undergo hydrolysis and degradation including dextrinization which in turn darkens the colour and affects the flavour. The study of **Kalbrener et al.(1971)** also showed that the threshold values for beany and bitter flavours in raw flour were low and were detected even at very low concentrations. They also stated that once these flavours are formed it is very difficult to remove them. Blanching of the beans before crushing them to prevent formation of the unwanted flavour

constituents due to action of lipoxygenase has been recommended by many workers including **Nelson et al (1971).**

2.8 SUPPLEMENTATION IN BREAD

2.8.1 Barley Flour

Physico-chemical and nutritional properties of cereal-pulse blends for bread making reported by **Dhingra S, Jood S (2002)** . The gluten content and sedimentation value of flour blends decreased and water absorption capacity increased with increase in the level of soybean and barley flour separately and in combinations to bread flour. Addition of 15% barley flour, 10% full fat soy flour, 10% defatted soy flour, 15% full fat soy flour + barley flour and 15% defatted soy flour + barley flour to wheat flour not only increased the total protein, glutelin (protein fraction), total lysine, dietary fibre and beta-glucan contents of cereal-pulse blends for bread making, but could also produce a product of acceptable quality.

Barley bread containing lactic acid improves glucose tolerance at a subsequent meal in healthy men and women. We concluded that barley bread containing lactic acid eaten at breakfast has the potential to improve second-meal glucose tolerance at a high GI lunch meal 4 h later reported by **Ostman EM et al.,(2002).**

Hassona HZ et al., (1993) studied high fibre bread containing brewer's spent grains and its effect on lipid metabolism in rats. Bread samples containing milled brewer's spent grain (BSG) at levels of 10-25% were prepared. The protein content of the

bread was found to be 15.4, 16.3 and 18.8%, when BSG was added at levels of 10, 20 and 25%, respectively. Fibre content however was 4.9, 6.4 and 7.5%, respectively. Amino acid pattern of the bread samples revealed that most of the essential amino acids were found in considerable amounts compared to the FAO provisional pattern with exception to lysine, threonine and tryptophan which showed deficiencies. The bread samples were fed to rats for 28 days, after which total lipids and cholesterol were measured. The results indicated impaired growth weight (7.1-10.0%) compared with the control. Total lipids as well as total cholesterol were also reduced by 5.7-8.0% and 6.0-8.3%, respectively. Sensory evaluations of prepared bread showed high score acceptance for fine bread, rolls and baton salie amounted to 70.0, 63.0 and 62.7%, respectively.

Shukla K et al., (1991) showed that glycaemic response to maize, bajra and barley. The postprandial glycaemic response to maize (*Zea mays*), bajra (*Pennisetum typhoideum*) and barley (*Hordeum vulgare*) was studied in a pool of 18 healthy volunteers and 14 patients having non-insulin-dependent diabetes mellitus (NIDDM). In response to maize, none of the variables examined was significantly different as compared to white bread. The glycaemic response to bajra was significantly lower than that to white bread in healthy subjects, but the two responses were indistinguishable in NIDDM subjects. The insulinaemic responses to bajra and white break were not significantly different in either group of subjects. The glycaemic response to barley was significantly lower than that to white bread in both groups of subjects. But the insulinaemic response to barley was significantly lower than that to white bread only in healthy subjects. In NIDDM subjects, there was a tendency for the response to barley to be higher than that to white bread 0.5 h after ingestion. Barley, with a low glycaemic

index (68.7 in healthy and 53.4 in NIDDM subjects) and a high insulinaemic index (105.2) in NIDDM subjects seems to mobilize insulin in NIDDM. This makes it a specially suitable cereal for diabetes mellitus.

Wheat bread quality is influenced by the substitution of waxy and regular barley flours in their native and extruded forms. The substitution of wheat flour with barley flour (i.e. native or pretreated/extruded) reduced the loaf volume. In the present study, breads made with 15% HTHM CDC-Candle flour had highly acceptable properties (loaf volume, firmness and colour) and it indicated that the use of extruded barley flours would be an effective way to increase the dietary fibre content of barley breads reported by **Gill S et al., (2002).**

The combined use of hull-less barley flour and xylanase as a strategy for wheat/hull-less barley flour breads with increased arabinoxylan and (1→3,1→4)-β-D-glucan levels. Bread-making with a composite flour (CF) consisting of 60% wheat flour (WF) and 40% hull-less barley flour, increased the total and soluble (1→3,1→4)-β-D-glucan and total arabinoxylan (AX) contents of dough and bread samples, but decreased the specific bread loaf volume. The results clearly showed that the combined use of hull-less barley flour and a xylanase active during bread making, lead to palatable breads with high total and soluble AX and (1→3,1→4)-β-D-glucan contents. The sum of total AX and (1→3,1→4)-β-D-glucan was 1.70% for WF bread and 3.06% for CF bread, while the sum of soluble AX and (1→3,1→4)-β-D-glucan was 0.49 and 1.41% for control WF and CF xylanase supplemented breads, respectively **(Trogh et al., 2004).**

The influence of (1→3) (1→4)-β-d-glucan-rich fractions from barley on the physicochemical properties and in vitro reducing sugar release of white wheat breads. Cereal β-glucan is regarded as a soluble dietary fiber, which has potential nutritional benefits within the food industry. This article explores the possibility of using a β-glucan rich fraction (BGF) extract from barley (*Hordeum vulgare*) in bread products. BGF was incorporated into bread mixes at 2.5% and 5% inclusion rates. Analysis of the pasting characteristics of BGF and wheat flour mixes revealed a decrease in peak and final viscosity related to the level of BGF addition. Dough extendibility increased with addition of 5% BGF compared with the control, probably because of the weak gel-forming capability of β-glucan, creating an elastic dough. However, loaf volume and height decreased with the addition of BGF. Analysis of the bread samples illustrated that 5% BGF inclusion resulted in a significant decrease in the release of reducing sugars over a 300-min digestion, compared with the control bread sample. The results showed a potential for the use of low levels of β-glucan to improve the nutritional quality of bread products reported by **Symons et al., (2006)**.

Başman A et al., (2004) showed that the properties and composition of turkish flat bread (Bazlama) supplemented with barley flour and wheat bran. Effects of increasing levels of wheat bran and barley flour on dough properties and bazlama quality were investigated. Part of the wheat flours were replaced with barley flour at 10, 20, 30, and 40% levels and Gerek bran mixture at 5, 10, 15, and 20% levels. Increasing levels of bran and barley flour caused decreases in all sensory properties. The deteriorative effect of barley flour on bazlama properties was generally more obvious when compared to bran supplementation. However, all bazlama samples were considered acceptable.

Penetrometer values of bazlama samples showed that increasing levels of barley flour created significantly softer bazlama. However, in bran-supplemented bazlama samples, effect of bran on softness was found to be insignificant in both cultivars. Bazlama samples supplemented with bran had lower *L* values and higher *a* and *b* values for color when compared to those supplemented with barley flour. In all samples, effect of increasing levels of barley flour on residual β-glucan was found to be insignificant in both cultivars. Acid detergent fiber and neutral detergent fiber values increased with increasing levels of bran, and the changes in both cultivars were similar.

Utilization of transglutaminase to increase the level of barley and soy flour incorporation in wheat flour breads. Addition of increasing levels of barley/soy flour (with and without TG) increased Farinograph water absorption in the soft and hard wheat cultivars. Dough resistance increased and extensibility decreased with TG treatment. TG showed great promise in processing of bread supplemented with barley flour, even at a very low level (0.25%, wt/ wt), but did not notably improve the quality of soy flour-supplemented breads **(Basman et al.,2006)** .

Hart M R et al.,(2006) showed that bread from sorghum and barley flours. Various additives were examined as possible aids in making bread from sorghum and barley flours. Good rise was achieved with doughs containing 45% solids. Several gums, especially 4000 centipoise methylcellulose, increased gas retention in sorghum bread and improved texture of both sorghum and barley breads. Several starches improved texture and loaf volume of sorghum bread. Glyceryl monostearate (GMS) improved the texture of sorghum bread but caused it to crumble badly. GMS improved softness in barley bread. Shortenings also

softened sorghum and barley breads. The effect of several processing variables on sorghum bread was studied along with 2 methods of imparting a sour fermented flavor to sorghum bread.

2.8.2 Soy Flour

Fortification of wheat- flour with high protein- high lysine material to increase protein content of baked products has been recognized for some years. The value of such fortification would mainly depend upon the acceptability of the baked products **(Ranhotra et al., 1974).** Soy protein concentrates and isolates have been experimentally incorporated in bread and other baked good **(Mizrahi et al., 1967; Wilding et al., 1968).** Defatted and full-fat soy flour is the primary protein forms used by baking industry. Addition of soy flour in wheat flour for preparation of bread is found to result in some changes in organoleptic characteristics. It also affects the freshness and keeping quality of bread. **Pollack and Geddes (1960)** and **Wolf (1970)** reported good keeping quality of soy fortified bread. Soy protein in baked products not only increased water absorption, but also enhanced moisture retention and thereby helped to maintain freshness of the products.

Rawat A et al., (1994) studied that Chapatis (unleavened flat bread) prepared from whole wheat flour and wheat flour –defatted soy flour (90:10) blend were evaluated for their quality characteristics .Soy fortified chapattis contained 28.8 and 19.0% higher protein and available lysine, than the whole wheat chapattis .The former also contained higher amounts of calcium, phosphorus and iron, than the latter . Soy –fortification increased protein efficiency ratio of chapattis from 1.3 to 1.7 and in vitro protein digestibility from 71.3% to

73.1%. Weights of liver and heart of the rat's .fed on wheat chapattis diet were significantly lower, than those observed in case of casein and soy-fortified chapattis diets. However, the weights of testis of rats fed on soy –fortified chapattis were significantly higher than those with other diets Soy-fortified chapattis were significantly higher than those with other diets. Soy fortified chapatti were softer than whole wheat chapatti, but retained 13% of the trypsin inhibitor activity, originally present in defatted soy flour. **Selvarj and Shurpalekar (1982)** prepared satisfactory bread by addition of 10 percent soy flour. However, further addition produced breads of poor to fair grade. The authors supported the use of surfactants with different hydrophilic and lipophilic balances to over come the deleterious effects of protein rich sources such as soy flour.

Blending with defatted soy flour at levels of 2, 4, 6, 8 and 10% in two wheat varieties (UP-319 and RR-21) was studied for its effect on bread making qualities. The protein, total ash, calcium and phosphorus contents increased in the blends and sedimentation values decreased marginally at higher levels of blending. Mixing time increased as the level of defatted soy flour increased upto 10%. In the alveograms, the height of curve (tenacity) increased with blending level. The extensibility of dough decreased inversely with defatted soy flour level. Loaf volume of bread decreased when soy flour level increased beyond two percent (**Misra P et al., 1991**). **Hallab et al.,(1974)** reported that Arabic bread supplemented with 10 percent soybean flour was highly acceptable when compared to control. **Levinson and Lemancik (1974)** stated that the addition of soy flour improved the eating quality of bread.

Bohn and Flavor (1945) studied the effect of soy flour on bread quality. They observed decreased loaf volume with added soy flour which might be attributed to the dilution effect of gluten by the addition of soy flour. The extensibility of dough and loaf volume of bread are mainly dependent on quality and quantity of gluten present in wheat flour. Since soy flour is devoid of gluten, it places an added stress on the gluten, when added to bread dough and also reduce the loaf volume. Therefore, soy flour can be incorporated in wheat flour for bread making up to a certain limit only. The high protein wheat flours will tolerate a higher level of soy flour addition as compared to weak flours **(Smith and Circle, 1978)**.

Finney et al., (1950) made satisfactory bread with blends of hard red winter flour and soy flour in the ratio of 92:8. They also reported that by using higher levels of potassium bromate in baking formula, a bread of equal quality, as reflected by crumb grain and loaf volume, could be obtained by using soy flour. The breads with soy flour exhibited creamy gray colour which varied with the limit and amount of soy flour used 5 min inactivated this enzyme. However, **Learmonth and Wood (1962)** reported that the alpha-amylase activity of raw soy flour was not significant in commercial bread making. **Paulsen and Horan (1965)** reported that addition of chemically treated soy flour produced bread with superior characteristics as compared to heat treated soy flour. **Hoover (1979)** pointed out that the incorporation of soy flour not only produced an acceptable bread but also improved the toasting properties and shelf life of the product. **Rao and Vakil (1980)** reported that addition of 0.5 percent soy lecithin improved sensory characteristics and acceptability of breads supplemented even with 15 percent of soy flour.

Ehle and Jansen (1965) studied the effect of various levels of soy flours, non-fat dry milk (NFDM), wheat gluten and lysine hydrochloride on loaf volume, crust colour, crumb colour and organoleptic properties. They observed that the addition of soy flour corresponding to 6 per cent NFDM affected the physical and organoleptic qualities slightly. **Bookwalter et al (1971)** reported that the use of extrusion cooked soy flour corresponding to 3 and 6 percent non-fat dry milk on an equivalent protein basis exhibited the baking properties similar to that of control. The addition of 15 to 20 percent of extrusion cooked soy flours produced a better loaf as compared to non-extrusion cooked soy flours. **Tsen et al (1975)** studied the effect of extruded soy products on the quality of bread and cookies. They reported that the addition of 12 percent extruded product at low temperature yielded better quality bread as compared to that at higher temperature.

Turro and **Sipos (1968)** found that the higher protein content of soy flour resulted in more water absorption whereas the higher level of water soluble proteins produced better grain and crumb colour of the bread. The authors reported that the addition of soy flour to the sponge in sponge dough method had a weakening effect on the dough and, therefore, recommended the addition of soy flour to dough. **Pomeranz et al., (1969)** noted that addition of soy proteins to bread diluted the wheat gluten and starch and resulted in depressed loaf and poor bread crumb texture. **Wolf (1970)** observed that the addition of soy flour in wheat flour gave an enhanced and brighter colour to the bread crust. This has been attributed to the reactions between the soy protein and the wheat flour sugars. **Ranhotra et al., (1974)** and **Abdel –Rahman** and **Youssef (1978)** reported that the addition of full-fat

soy flours to a level of 15 to 20 percent produced bread of acceptable volume, flavour and over all quality with higher protein content and better amino acid balance.

Deneck et al., (1973) advocated the use of enzyme active soy flours in breads. He reported that these flours contained enzyme, lipoxygenase which caused the oxidation of the lipid protein linkage resulting hydrolization and hence in better dough development. In addition, the enzyme, lipoxygenase produced peroxides which oxidized carotenoids of the flours and resulted in bread with whiter crumb. **Eskin and Pinsky (1977)** reported that the enzyme lipoxygenase prevented lipid binding during dough mixing and thus ensured the effectiveness of added shortening fat in improving the volume and softness of breads. **Keiffer and Grosoh (1980)** studied the dough improving action of soy flour extracts and purified lipoxygenase by using wheat flours of normal and poor baking qualities. They reported that the lipoxygenase in the dough increased the mixing tolerance and dough stability and improved the bread loaf volume. Similar effect was also observed with flours of poor quality in addition to the better handling properties. The addition of linoleic acid to dough having lipoxygenase further increased dough strength.

Skorikova (1979) studied the effect of soybean flour, whey, ascorbic acid and sun flower or soybean oil on the quality of standard bread. He prepared a bread by addition 10 percent soy flour with vegetable oil or 15 percent whey during the kneading of dough. However, the addition of ascorbic acid decreased the loaf volume. The bread obtained was comparable to standard bread as reflected by the product characteristics such as appearance, aroma and condition of crumb, crumb compressibility, volume porosity and height / diameter ratio.

Malinowska E et al., (2005) focus on concentration of several bioelements in bread and other plants supplements. Concentration of Ca, P, Fe, Zn and Cu were determined in grain products such as bread and Crisp bread with natural supplements, and also in seeds and other cereal products available on Polish market, added to improve bread's quality and nutritional value. The contents of minerals in bread were as follow: 35.3-78.4mg Ca; 88.4-364mg P; 3.03-5.63mg Fe; 1.96-3.15 mg Zn and 0.27-0.64mg Cu in 100g of product. Among the analyzed products, the highest level of calcium was recorded for poppy and sesame seeds. Based on the data obtained it was possible to estimate the realization of the recommended daily intake of bioelements with the analyzed products for an adult person.

2.8.2.1 *Effect of Heat Treatment on Nutritive Value*

Changes in the nutritive value of beans are affected by the severity of heating and their moisture content **(Liener,1978).** Proper heating improves the nutritive value by destroying the growth inhibitors or anti-nutritional factors. But heating must be carefully controlled. Excessive heating has been reported to damage lysine and cystine **(Fritz et al., 1947, Evans et al ., 1951; Taira, 1966; Liener, 1978).**This deficiency can be over come by supplementation with lysine and sulphur containing amino acids. Excessive heating also causes development of toxicity and loss of digestibility **(Evans et al., 1947).** Excessive heating also hydrolyses sucrose giving appreciable levels of reducing sugars. These reducing sugars interact with lysine making it physiologically unavailable **(Delvalle, 1981).** In addition to cystine and lysine other amino acids including arginine, tryptophane , histidine

and serine have also been found to be either partially destroyed or inactivated as a result of over heating **(Liener, 1978)**.

2.8.2.2 *Soy Fortified Bread*

Bricker et al (1945) reported that the biological value of white flour was increased to 55 from 41 by adding 19 percent soy flour. **Shamsuddin (1972)** found that a bread with 12 percent soy flour exhibited higher levels of essential amino acids than white bread. Lysine content was almost doubled. Bread supplemented with 14 percent non-fat dry milk solids had a lower available lysine content than bread containing 12 percent soy flour. In-vitro digestibility studies showed that soy flour fortified bread exhibited higher protein quality than white bread. **Hoover (1979)** reported that the addition of higher levels of soy flour brought dramatic changes in the nutritional quality of bread. The PER values for the breads having 3, 6 and 12 percent soy flour were 0.83, 1.30 and 1.95, respectively as compared to 0.7 of white bread.

Radaeva (1980) pointed out that it was possible to produce dietetic high protein breads enriched with wheat and soy protein concentrates. **Hoover (1974)** reported that blending of wheat flour with soy flour considerably improved the nutritional value of the bread. He obtained PER of normal bread in the range of 0.7 to 1.0 which increased to 1.3 and 1.9 by adding 6 and 12 percent soy flour, respectively. The protein content increased from 8 percent to 11 and 12 percent respectively.

Tsen et al (1976) reported that the protein and mineral contents of wheat buns increased by 27.5 percent 29.2 percent, respectively when 12 percent soy flour was added. The authors also reported that the buns with added soy flour were larger in size and darker in colour with grain similar to those prepared from wheat alone.

2.8.3 Gluten Powder

Addition of 4% vital gluten and 0.15% disodium phosphate was found to be beneficial for getting good quality flat breads from sprouted wheat. Good quality noodles could also be prepared from moderately sprouted wheat's with the addition of 2% vital gluten and 0.15% di sodium phosphate .However, higher sprouted wheat's ,require extra addition of gluten to the flour to produce quality noodle(**K.S.Sekhon[1] et al.,1994**). The present work was planned study the effect of addition of various additives and change of pH to 4.2 on dough development of gas release characteristic of sound and sprouted wheat during fermentation with chop in rheofermentometer F_2. **Miller and Hoseney (1996)** reported that addition of gluten improved the specific loaf volume crumb grain and scores.

A combination of lowering the pH , increasing the salt concentration and adding L-cystine HCL was reported to be effective in producing acceptable quality bread from high maltose- value flour **(Ranhotra et al. 1977). Mailhot and Patton (1986)** reported that none of the rheological and chemical measurements are capable of fully predicting the end performance of flour. The ultimate criteria of quality of flour are its performance in bake test and the acceptability of the product by human senses.

The extensibility of dough and loaf volume of bread are mainly dependent on quality and quantity of gluten present in wheat flour. Since soy flour is devoid of gluten, it places an added stress on the gluten, when added to bread dough and if added in excess, it will affect the texture of the bread and also reduce the loaf volume. Therefore, soy flour can be incorporated in wheat flour for bread making up to a certain limit only. The high protein wheat flours will tolerate a higher level of soy flour addition as compared to weak flours **(Smith and Circle, 1978**).

2.8.4 Yeast

Use of *Saccharomyces cerevisal* strains for bread making from different cereal flour blends. They conducted using 9 *S. cerevisial* strains ('KAS,'KOT', Hefe, vee, HAV-21 CB4, 'TBY',DBY' and 'a Hap' for their maltase activities (MA) dough raising capacities (DRC) breadmaking qualities cereal flour blends. The results showed that both DRC and MA affected the baking quality of a yeast strain, commercially used strain of *S. cerevision* 'KOT' was found superior for breadmaking wheat flour strains 'HAU-21' , 'Hefe' and 'DB4' Produced good quality breads using a blend of 10% sorghum ,triticale and soyabean flour with wheat flour, respectively **(Ravita and Chaudhary 1999)**. Yeast belonging to genus *Saccharomyces* is the most exploited microorganism commercially this is probably due to the increasing demand for the yeast leavened bakery products especially composite bread **(Mustafa 1973; Sahni and Krishnamurthy 1975; Badi et al 1976; Bastos 1981; Olatunji et al 1982).**

Good bakers yeast should have good dough raising capacity (DRC) and high maltase activity (MA) **(Ponte and Reed 1987)**. But the properties of a yeast strain are affected by the gluten content, protein content, amylolytic activity and the total carbohydrates present in flour used for bread making **(Singh et al 1990; Khatkar and Schofield 1997)**. This indicated that for producing acceptable breads, different cereal flour blends may require different *S. cerevisial* strains. The low production and acceptability of composite flour breads over wheat flour bread necessitated the screening of available bakers yeast for bread making quality using different cereals flour blends. This study was undertaken with a view to develop wheat bread with blends of other flours, i.e. triticale, sorghum, pearl millet and soybean using different strains of baker's yeast.

Yeast ferments sugars and continuously produces carbon dioxide in the aqueous dough phase is saturated with carbon dioxide most of the carbon dioxide diffuses into the air cells that are formed in the dough during mixing This is attributed to the fact that the rate of diffusion of carbon dioxide in the dough and its ultimate evaporation into the surrounding atmosphere is slow. This is due to the presence of continuous gluten proteins film, Pentosans and lipids **(Honseney 1984)**. Baker's yeast fermentation consists of five aerobic fermentation stages in a medium containing molasses, urea, Phosphoric acid, minerals and vitamins along with downstream Process The fermentation is carried out at a pH between 4 and 5 a temperature between 28-30^{0}C for periods 7-20h Different types of faults may occur during both upstream and downstream Processes. These faults may lead to huge wastage and poor quality of product that can be restricted with prompt and proper diagnosis by an intelligent expert system **(Quantrile and Liu 1991)**.

Seibold et al., (2002) was reported on dried baker's yeast which may be used in bread mixes, etc and has a shelf-life of several months in air tight and watertight Packs comprises instantly-active dried baker's yeast which may be used in bread mixes, etc. and has a shelf-life of several months in airtight and watertight packs comprises instantly-active dried baker's yeast Particles with a protective coating based on oxidized wheat starch, tricalcium phosphate and magnesium stearate. The coated yeas preparations are made by communicated of a mixture of conventional dry baker's yeast (as granules of diam 1-5mm) and 5-10% coating medium. Diam of the coated yeast particle is 0.3-0.7mm. The protective coating dissolves during preparation of the dough.

2.8.5 Surface Active Reagent

The effect of surfactant gels on dough rheological characteristics and quality of bread was studied by **Azizi MH et al., (2004)** . Sodium stearoly-2-lactylate (SSL), diacetly tartaric acid esters of monoglycerides (DATEM), glycerol monostearate (GMS), and distilled glycerol monostearate (DGMS) surfactant gels were made with water and varying shortening contents. The results indicated that the surfactant gels changed the rapid visco analyzer characteristics of wheat flour, and the presence of shortening in gels further altered the characteristics. All surfactant gels improved the volume, specific volume, texture, and overall quality scores of bread, but the improvement varied for different surfactants. By increasing the addition of shortening in gels, though the quality characteristics further improved, the response to surfactant reduced by increasing shortening content

Tsen et al (1971) and **Marnett et al (1973)** used SSL and calcium stearoly-2-lactylate to produce an acceptable bread with 12 percent soy flour using sponge dough method. The soy fortified bread thus produced was comparable to control bread in acceptance as reflected by organoleptic evaluations. **Tsen and Hoover (1973)** also emphasized the use of dough conditioners to produce an organoleptically acceptable bread. **Tsen et al (1974)** prepared acceptable high protein bread from wheat flour fortified with 20 percent extruded soy products. **Tsen and Hoover (1973)** noticed that addition of soy flour towards higher levels adversely affected rheological as well as baking properties of wheat flour. They reported that the addition of 12 to 28 percent FFSF exhibited small loaf volume and poor grain score of the bread. But the addition of 0.5 percent SSL promoted the incorporation of soy flour upto 24 percent to produce acceptable bread. The use of ethoxlated monoglycerides (EM) also gave an increase loaf volume but a lower grain score as compared to the of SSL.

2.8.6 Salt

Common salt (NaCl) is an essential ingredient in bread and is used as a flavour enhancer and dough stabilizer **(Salovaara 1982).** Consumption of sodium chloride in excess has been associated with hypertension in certain sensitive individuals (**Gillette 1985)** and low sodium intake has been recommended for such individual **(Ndabiunze and Lahtinen 1989)**. Studies have been reported on the possibilities of replacing part of common salt with potassium or magnesium chloride in bread **(Salovaara 1982;Guy1986).** Though no serious adverse effect was found on dough characteristic or loaf quality, a slight astringent mouthfeel was ,however, felt when 50% of common salt

was replaced with potassium or magnesium chloride (**Salovaara 1982; Stroth et. al 1985**). Several salt substitutes, such as sendha (rock salt) or the blend of different salts, containing available in India.

Srivastava A K et al., (1994) reported that in general, the common salt substitutes reduced water absorption capacity, but increased dough development time, stability extensibility, resistance to extension and stiffness of the dough. The extent of changes with different common salt substitutes was almost similar and comparable to the dough made with common salt. Sendha yielded bread which had comparable taste and over all quality to that made with common salt.

2.9 SHELF –LIFE

A number of additives are increased in bread formulation to improve shelf-life and organoleptic properties of bread. Acetic acid increases the shelf-life of bread and has been suggested as an alternate to potassium bromate in bread making (**Seguchi et al, 1997**). **Kaur and Singh (1999)** reported the effect of acetic acid and carboxy methyl cellulose on rheological, gas release and bread making properties. **Wehrle et al (1997)** reported the addition of salt strengthened dough structure and decreased the effects of over mixing L-cystenine HCL acclearte reactions within and between molecules in the dough, which has significant effect on visco-elasticity, and gas holding properties of dough.

John P et al., (1998) studied on shelf life and acceptability of minimally processed bread fruit pieces pelled bread fruits were diced into 3 different sizes, viz, large (8×6×4cm), medium (4×3.2cm) and chip size units (2×1×1.25cm). They were either steeped continuously or infiltrated in solution of potassium metabisulphite (KMS) having 500, 1000, 2000, or 5000ppm SO_2 and packed in polyprophylene (250gauage) Pouches either with in-Package SO_2 fumigant or filled with CO_2 and stored at 28^0C or 0^0C respectively and were sensorial acceptable ($P<0.01$) and those infiltered chip size samples in 500ppm SO_2 had shelf-life of 75 and 120 days out 28 and O^0C respectively.

2.10 TEXTURE OF BREAD

The texture of food is one of the most challenging areas of food characteristics. Texture of food defines as the response of the tactile senses to physical stimuli that result from contact between some part of the body and food **(Bourne 1982)**. **Voisey, et al (1980)** reported that by means of measuring the amplitude of force fluctuation during test. They showed that a minimum module added to the electronic force recording system gives a direct read out of amplitude.

Kadan., et al (2001) studied some of samples of baked in a home bread machine by physicochemical methods and compared with local commercial whole-wheat bread. The results showed that rice breads had less specific volume, harder texture, and were more prone to retrogradation during storage than whole wheat bread. All stored breads showed a peak at about 52^0C by differential scanning calorimetry (DSC) analysis, which is characteristic of retrograded starch. However, the DH for rice bread was about 3 times

the value of whole-wheat bread, suggesting its strong tendency to retrograde. X-ray diffraction (XRD) evaluation also indicated the appearance of a strong 2u peak between 16.70C to 17.00C in rice bread than in whole- wheat bread, which is consistent with starch retrogradation.

Vickers and Christensen (1982) studied on the oral and instrumental sensory evaluation on 16 samples. They measured slope, peak force and deformation of fracture from snap test at four deformation rates. The instrumental parameters also showed that young's modulus generally had the highest correlation with the crispness of all foods and peak force generally had the highest correlation with the crispness of all foods and peak force generally had the highest correlation with the firmness.

Chapter 3

Materials and Methods

3.1 Source of Material

The particulars regarding materials used in the present investigation are described below

3.1.1 Refined flour (Maida), Barley flour, Defatted Soy flour and Gluten powder

Flour were purchased from local market Jhansi and evaluated for their moisture, gluten, protein, fat, ash, crude fiber, calcium, phosphorus, iron, acid insoluble ash, pigment, wet gluten and dry gluten.

3.1.2 Salt, Sugar, Edible oil and Baker yeast

Commercially available "TATA" salt, sugar, fourtune brand refined oil and yeast were purchased from local market Jhansi.

3.2 Role of ingredients in bread making

3.2.1 Yeast

- Leavens bread
- Adds characteristics
- Sucrose is fermented to alcohol and carbon dioxide
- Glucose, fructose is used up first, followed by maltose
- Sugars are naturally present or added
- Yeast activity is best at 35 ^{0}C
- *Saccharomyces cerevisiae* used (or S. exigus & S. inusitatus in sourdough)

- Production of carbon dioxid is relatively slow so dough must be elastic enough to hold it

3.2.2 Fat

- Added fat could increase the final loaf volume (up to 3% addition) and a relationship between loaf volume increase and melting point of the fat has been observed such that higher the melting point of the fat, greater the increase in volume.

- Tenderizes and moistens bread as a result of the lipid slowing moisture loss by coating starch. The fat will also coat the gluten. Commercially emulsifiers are added (up to 20% of the fat weight) to aid in dispersion of fat.

3.2.3 Sugar

- Can increase yeast fermentation
- Competes for water needed for gluten development
- Retains moisture, tenderizes
- Enhances browning reactions i.e. darkening of crust

3.2.4 Salt

- Controls yeast fermentation
- Forms strong ionic bonds with side chains on flour proteins, makes the proteins less mobile and gluten tougher and less extensible

- Inhibits proteases that digest protein and hence protects gluten structure
- Adds flavour

3.2.5 Liquid

- Water or whole milk can be used
- The amount used depends on the flour – soft flour needs more water
- If milk is used the milk must be scalded first (held for 1 min at 92^0 C) before addition. This denatures the serum proteins that would normally interfere with flour proteins. The milk obviously must be cooled before addition so that you do not kill or injure the yeasts.

3.2.6 Flour

The preferred flour for bread is bread flour. This flour contains between 14 – 17% of protein and forms strong gluten.

3.2 Preparation of bread

3.2.1 Control bread

Bread was prepared by straight dough **(AACC, 1976)** procedure. The following steps were carried out for making bread.

Flow chart-

All the ingredients are mixed together for 5 minutes

(Flour, sugar, salt, yeast, water etc)

↓

Fermentation (24-28^{0}C) for 150minutess

↓

Kneading and punching (2 minutes) by hand to removing gases (knock back)

↓

Refermentation (24-28^{0}C) for 25 minutes

↓

Sheeting/ moulding for 60 minutes

↓

Proofing (30^{0}C temperature for 60 minutes)

↓

Baking (220 ^{0}C for 30 minutes)

↓

Cooling (2 hrs. at room temperature)

↓

Packing (Food grade polythene)

↓

Storage (1. Room temperature)
(2. Refrigerated temperature)

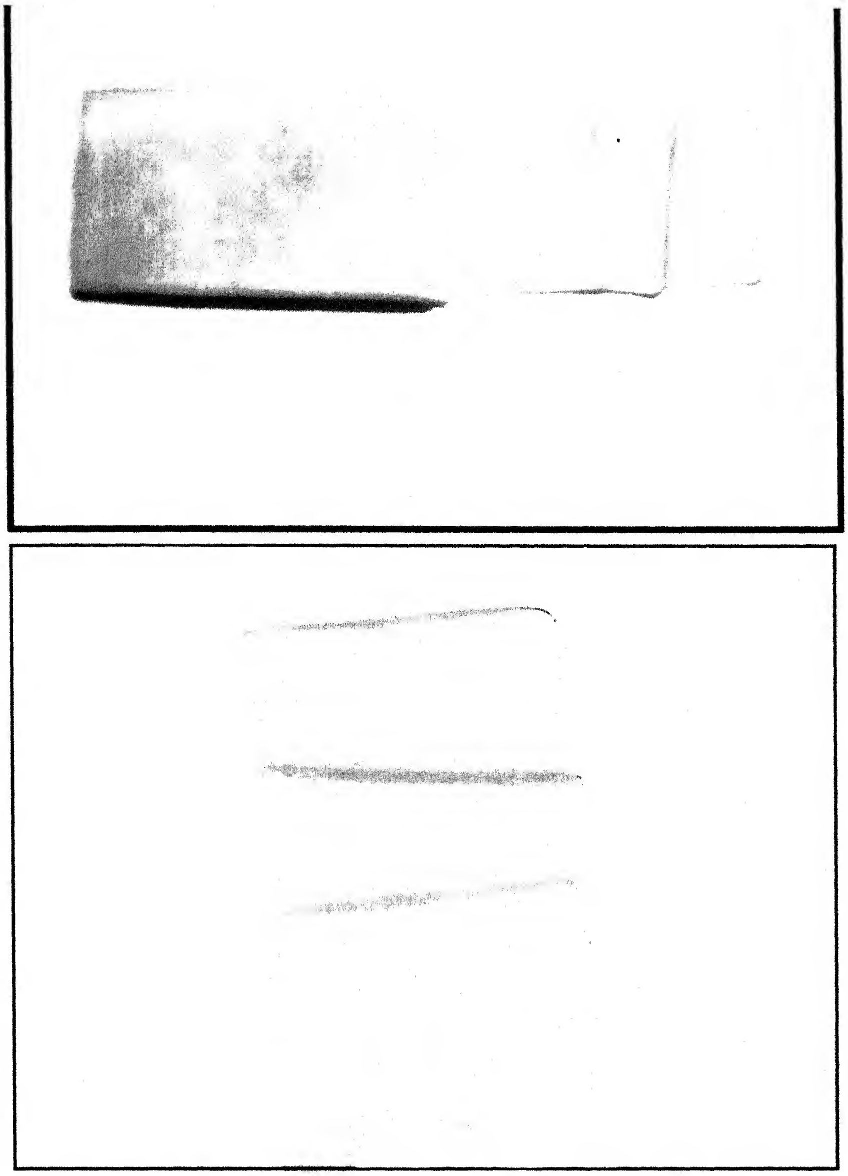


Plate- 1 White flour bread (Control sample)

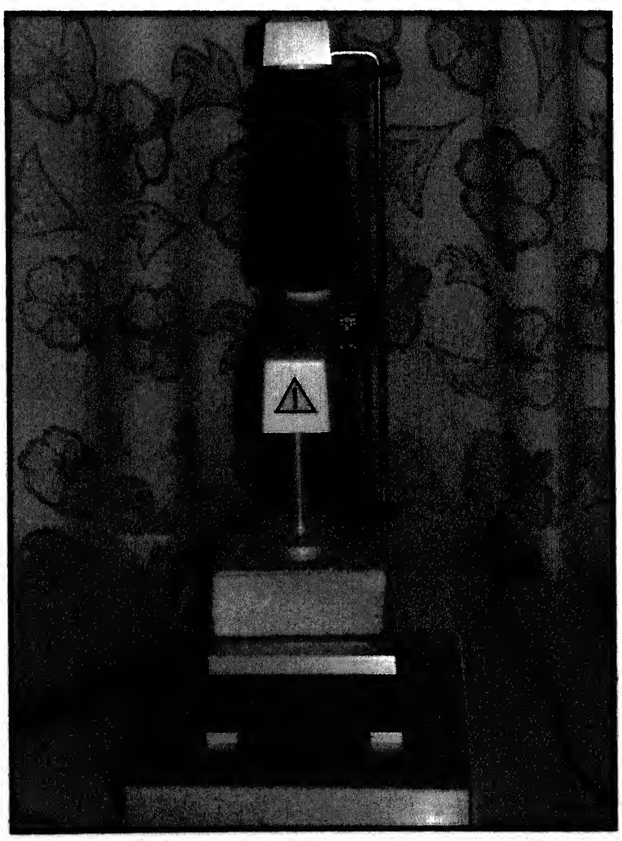


Plate-2 Stable Micro Texture Analyzer (Model TAXT2i)
(Probe Size- P 75)

3.3.2 Standardization of Ingredients

The control sample was prepared by straight dough method. The barley flour and defatted soy flour were incorporated in the white flour and their amount was standardized on the basis of their physico-chemical characteristic, sensory evaluation & texture profile analysis.

Barley flour and defatted soy flour which were passed through 50 mesh sieve was incorporated in white flour. Barley flour and defatted soy flour were added in white flour as 0, 5, 10, 15 and 20 percent in both the cases.

The bread was prepared by standard method. The bread thus obtained was subjected to physico-chemical, sensory characteristics and textural profile analysis for selecting the optimized level of barley flour and defatted soy flour. The incorporation of barley flour and defatted soy flour in white flour upto 15 percent and 10 percent, respectively most suitable and acceptable.

3.3.3 Standardization of other ingredients in barley flour and defatted soy flour incorporated bread

The other ingredients namely gluten powder, surface active reagent (SSL) were optimized in order to improve the physical, textural and sensory characteristics of bread prepared with 15 percent and 10 percent barley flour and defatted soy flour incorporated

in white flour, respectively. While optimizing one ingredient the other ingredient were kept constant. The gluten powder was mixed 2, 4, 6, and 8 percent and surface active reagent (SSL) was mixed 0.5, 1.0, 1.5 and 2.0 percent level.

3.4 Physical characteristics of flour

3.4.1 Water absorption

The water absorption value was determined by the method given by **Abbound et al., 1985.** Hundred gram of flour was taken in a plastic bowl, water was added gradually with the help of a burette and mixing was done by hands. It was carried out until smooth dough of desirable soft consistency was obtained. The consistency of dough was judged with the help of fingers. The water absorption values were expressed in percentage as

$$\text{Water absorption percent} = \frac{\text{Water absorbed x 100}}{\text{Weight of sample}}$$

3.4.2 Sedimentation value

This was performed according to **AACC (1969)** procedure. Wheat flour (3.2 gm) was taken in a graduated stoppered cylinder. Fifty ml of water containing 4 ppm bromophenol blue was added and the contents were mixed properly by shaking hand to get uniform suspension. The measuring cylinder was then placed on a mechanical shaker for 5 minutes. Twenty five ml of lactic acid reagent (100ml of lactic acid stock solution (250 ml of lactic acid made to 1 liter and refluxed for 6 hours) and 200 ml of iso-propanol added water, made upto 1 liter) was added to the flour suspension and mixed again for 5

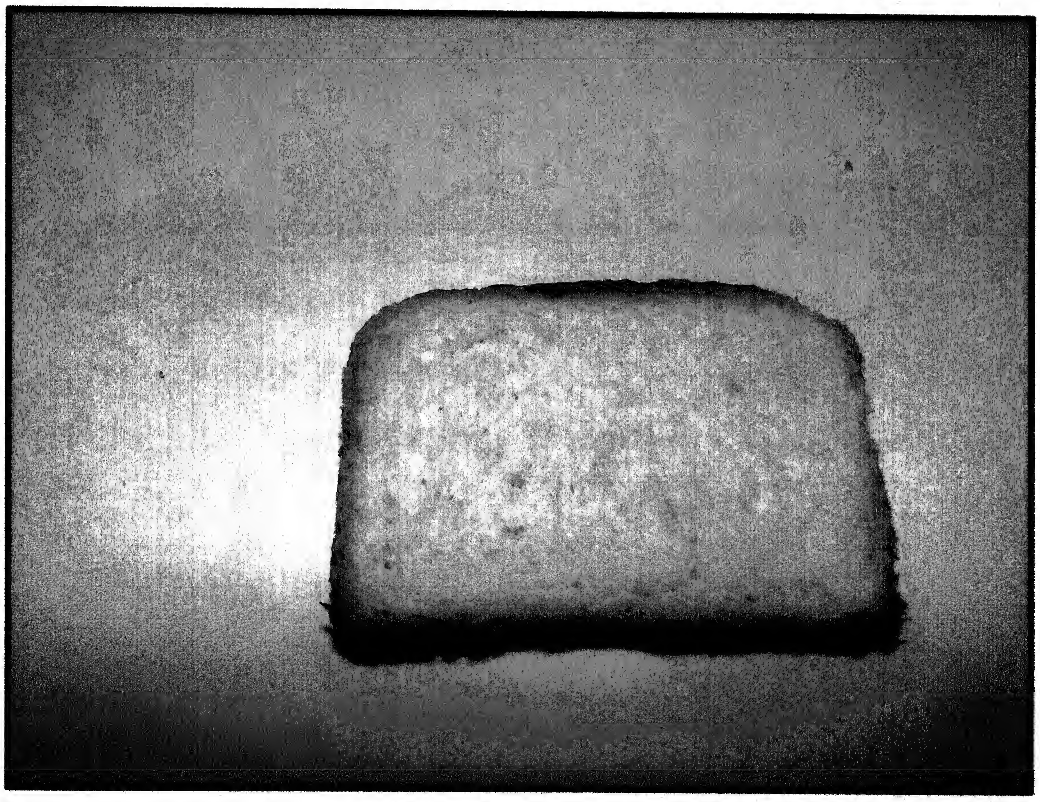


Plate - 3 Final Product I (15% Barley flour, 4% Gluten powder, 1.5 % Surface active reagent (SSL))

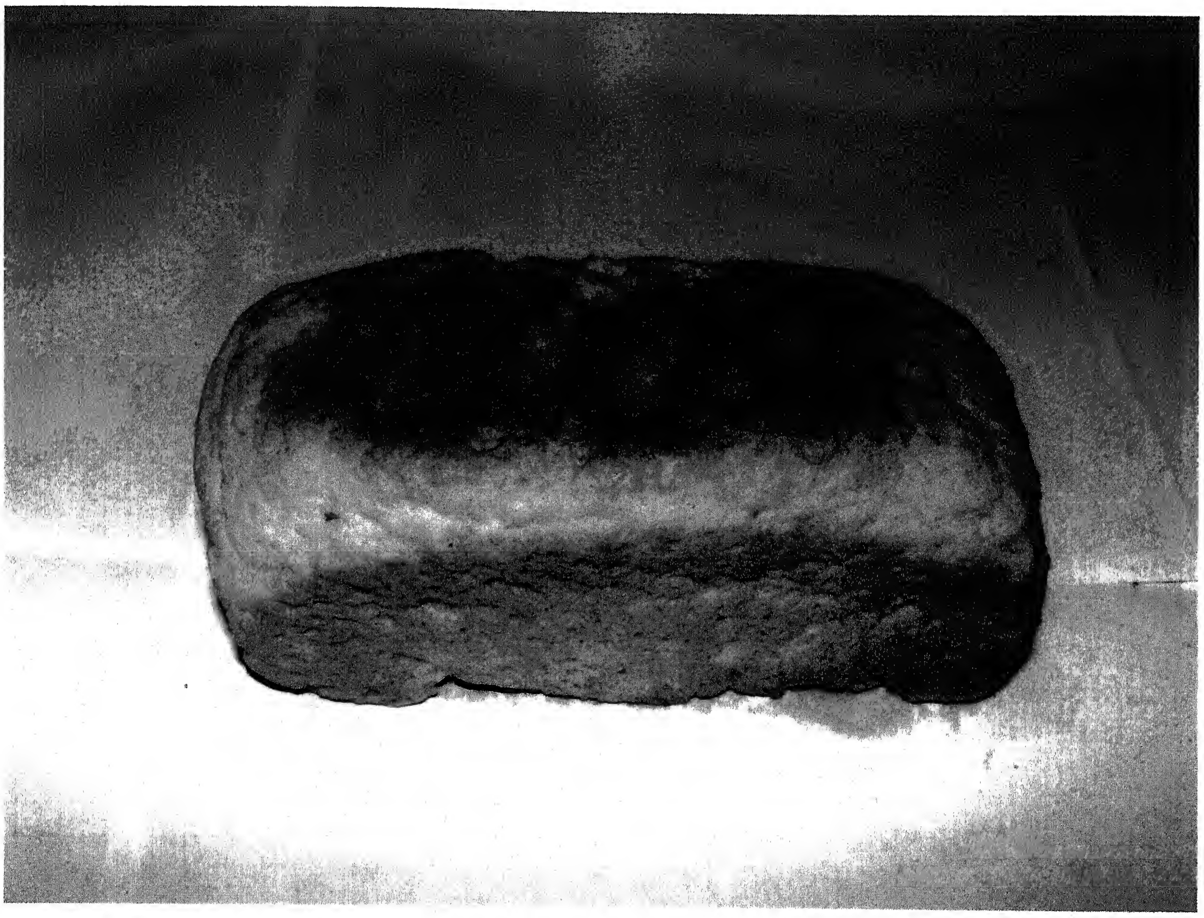
minutes. The cylinder was allowed to stand in upright position for 5 minutes and the volume of sediment read.

3.4.3 Polshenke Value

The procedure of Welsh and Norman **(AACC, 1972)** was followed. Three gram of flour was made into dough with 1.8 ml of yeast suspension (2.2 percent). The dough was kneaded well between the palms and immersed in a beaker containing 70 ml of water at 30^0C water bath. The beaker was transferred to a constant temperature (30^0C) water bath. The time of immersion and the time when dough ball began to disintegrate were noted. The time lapse between these two stages in minutes was expressed as polenshke value.

3.4.4 Gluten content

The gluten content in white flour was determined by **AACC (1969)** procedure. Hand washing method was used. Twenty five gm of flour was taken, made in to a dough by mixing with 12 to 15 ml of tap water, immersed in water for one hour and the dough kneaded well by hand in a gentle stream of tap water over a bolting cloth, until starch and other soluble components were removed. This was checked by observing the cloudiness of water obtained by squeezing the gluten. The gluten thus obtained was pressed between the palms to squeeze out water and make it as dry as possible. After weighing, the wet gluten was kept in an oven at 100^0C to dry. The gluten till constant weight was obtained. The weight of wet and dry gluten was noted. The results of dry and wet gluten were expressed as percentage. Wet to dry gluten ratio was also calculated.



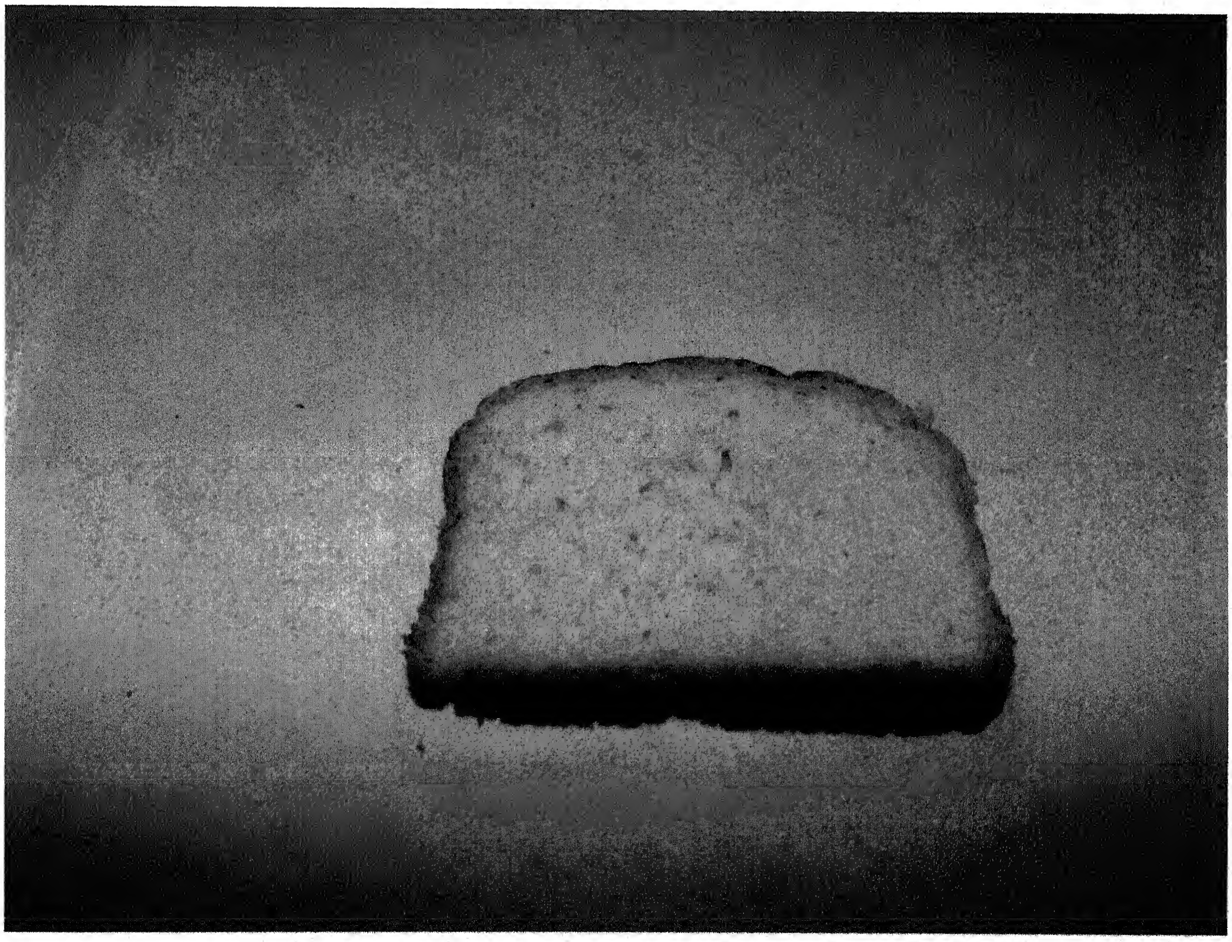


Plate- 4 Final Product II (10% Defatted soy flour, 4% Gluten powder, 1.0% Surface active reagent (SSL))

maximum load cell was used and the cross –head speed was set to 1.5 mm/s for a total travel of 40 mm and post test speed of 10 mm/s. The absolute peak force was considered as the hardness of the bread. The two test replicates were performed on each of sample tested. The force has been expressed in gram.

3.6 Chemical analysis of ingredients and bread

The chemical analysis of raw materials and bread was done using the following procedures.

3.6.1 Moisture

This was determined by **AOAC (1984)** method. Ten g sample was taken in a dish and kept in an oven maintained at 100^0C ± 1 until constant weight was obtained. The loss in weight was used to calculate percent moisture as follows:

$$\% \text{ Moisture} = \frac{\text{Loss in weight X 100}}{\text{Weight of sample}}$$

3.6.2 Protein

The protein content of different samples was determined by kjeldahl procedure as described in **AOAC (1984)**. Two g of sample was digested with 5 g of digestion mixture (10 parts of potassium sulphate and 1 part of copper sulphate) and 20 ml of concentrated sulphuric acid in Kjeldahl flask until the contents were carbon free. The digested sample was made upto 100 ml. An aliquot of 10 ml was distilled with excess of 40 percent

sodium hydroxide and liberated ammonia was collected in 20 ml of 2 percent boric acid containing 2-3 drops of mixed indicator (20 mg methyl red and 10 mg of bromo- cresol green in 100 ml of 95 percent ethyl alcohol) and titrated against 0.1 N hydrochloric acid. The nitrogen content in the sample was calculated by the following expression. The conversion factor of 5.70 and 6.25 were used to convert nitrogen into protein in wheat flour and barley & soy flours, respectively.

$$\text{Percent Nitrogen} = \frac{14 \times \text{N of HCL} \times \text{Titre value (ml)} \times \text{dilution factor} \times 100}{\text{Weight of sample (g)} \times 1000}$$

Percent Protein = Percent Nitrogen x Conversion Factor

3.6.3 Crude Fat

Fat content in the samples was estimated by Soxhlet extraction method **(AOAC, 1984)**. 5 gm. of sample was transferred to a thimble and extraction was carried out for 4 - 8 hrs in Soxhlet extraction assembly using petroleum ether (40-60^{0}C). After extraction, the solvent was evaporated in an oven at 100^{0}C for 30 min. After cooling, the flask containing crude fat was weighed. Percent crude fat was calculated as follows.

$$\text{Crude fat \%} = \frac{\text{Weight of fat} \times 100}{\text{Weight of sample}}$$

3.6.4 Total Ash

AOAC (1984) procedures were followed for ash determination. Ten g of sample taken in a silica dish was ignited on a heater and later shifted to a muffle furnace until clean ash was obtained. The temperature of furnace was raised to $600^0C \pm 15^0C$. The weight of residue was noted and the percent ash was determined as follows.

$$\% \text{ Ash} = \frac{\text{Weight of residue x 100}}{\text{Weight of sample}}$$

3.6.5 Crude fiber

The crude fiber content in various samples was determined using **AACC (1976)** method. Two gm of sample was digested with 200ml of 1.25 percent sulphuric acid for 30 min. After filtration through a linen cloth, the residue was washed with boiled distilled water until it was free from acid. The acid free residue was then digested with 200 ml of 1.25 percent sodium hydroxide for 30 min. The contents were filtered hot through linen cloth. The residue was transferred to a gooch crucible, which had been prepared previously with a thin but close layer of ignited asbestos and washed with boiled distilled water until the residue was alkali free. Finally, the residue was washed with 15 ml of 95 percent ethyl alcohol. The content of crucible was dried to a constant weight at 100^0C. The dried residue was ignited in a muffle furnace at 550 ± 15^0C for 30 min. the percent loss in weight was expressed as crude fiber.

$$\% \text{ Crude fiber} = \frac{\text{Loss in weight X 100}}{\text{Weight of sample}}$$

3.6.6 Carbohydrate (by difference)

The percent carbohydrates were calculated by subtracting the sum of moisture, protein, fat, crude fiber and ash from 100.

3.6.7 Pigment content

Place 10 g flour in 125 ml flask and from pipette add 50 ml H_2O saturated n-butyle alcohol. Stopper flask tightly, shake well for 1 min, and let stand for 15 min. protected the flask from sunlight. Reshake well and filter through 12.5 cm folded paper (Eaton- Dikeman Co. No. 192, or equiv.), collecting filtrate in 50 ml Erlenmeyer or suitable container. Fill 1 cm cell with flour extract and duplicate cell with corresponding solvent. Read absorbance at 435.8 nm with spectrophotometer. From average of 3 readings pigment as carotene in ppm was calculated from the following formula **(AOAC, 1984)**.

C = 30.1 X absorbance
Where C = Pigment as carotene in ppm

3.6.8 Minerals

For the determination of minerals viz., calcium, phosphorus and iron acid soluble ash was used. Ash obtained from 5 g of sample was boiled with 25 ml of 10 percent hydrochloric acid for 30 min and filtered through an ash less filter paper (Whatman No. 42), washed with hot water until washings were acid free. The filtrate was made up to a 100 ml and retained for the estimation of calcium, phosphorus and iron.

3.6.8.1 Calcium

Calcium content in samples was determined by procedure described by **Ranganna (2003).** Ten ml of ash solution (obtained above), 25 ml of distilled water and 10 ml of saturated ammonium oxalate were taken in a beaker. To this, 2 drops of methyl red indicator were added and the p^H of the contents was adjusted to 5.0 using diluted ammonia (1:1) and diluted acetic acid (1:4) solution. The contents were boiled and left at room temperature for overnight. Next day, the contents were filtered through Whatman No. 42 filter paper. The residue thus obtained was washed with hot distilled water until it became oxalate free. The filter paper was broken by a pointed glass rod and washed with 10 ml of hot dilute sulphuric acid (1:4) followed by distilled water. The contents were heated to 80^0C and titrated against 0.01 N potassium permanganate to a stable pink colour. Finally, the filter paper was also dropped in the solution and titration was completed. Calcium content was calculated as follows:

$$\text{Calcium (mg/100g)} = \frac{\text{Titre value x N of KMnO4 x 20 x Total vol. of ash solution x 100}}{\text{ml. of ash solution taken for estimation} \times \text{Weight of sample taken for ashing}}$$

3.6.8.2 Phosphorous

Phosphorus content was estimated according to the procedure described by **Ranganna (2003).** Five ml of ash solution and 5 ml molybdate reagent (25 g of ammonium molybdate dissolved in 400 ml of distilled water, added to 500 ml of 10 N sulphuric acid and final volume made to 1 liter with distilled water) were taken in a 50 ml of volumetric flask. To this, 2 ml of amino napthol sulphonic acid solution (0.5 g 1-

amino-2- napthol, 4- sulphonic acid, 30 g sodium bisulphate and 6 g sodium sulphite, dissolved in 250 ml of water, left for overnight and filtered) was added and the volume made up to 50 ml using distilled water. This was allowed to stand for 10 min and the colour was measured at 650 nm in a spectrophotometer. For standard, 0.439 g potassium di- hydrogen phosphate and 10 ml of 10 N sulphuric acids were dissolved in water and the volume was made to 1 liter. Five ml of this was used for analysis. The phosphorus content was calculated as follows:

$$\text{Phosphorous (mg/100g)} = \frac{\text{mg of phosphorus in aliquot of ash solution taken for estimation} \times \text{Total volume ash solution} \times 100}{\text{ml of ash solution taken for estimation} \times \text{Weight of sample taken for ashing}}$$

3.6.8.3 Iron

Iron content in the sample was determined by the method as described by **Ranganna (2003).** 5 ml of ash solution (described earlier), 0.5 ml of concentrated sulphuric acid, 1.0 ml of saturated potassium persulphate solution and 2 ml of 3N potassium thiocyanate were added. The volume was made upto 15 ml with distilled water. For blank, 5 ml distilled water was taken in place of the sample, whereas for standard 1.0 ml of saturated iron sulphate (0.702 g ferrous ammonium sulphate in 1 liter water) was taken. The colour developed was measured at 480 nm using a spectrophotometer. The iron content of the sample was calculated as follows.

$$\text{Iron (mg/100g)} = \frac{\text{O.D. of sample} \times 0.1 \times \text{Total volume of ash solution} \times 100}{\text{O.D. of standard} \times 5 \times \text{Weight of sample taken for ashing}}$$

3.7 Sensory Evaluation of bread

The acceptability of breads prepared from white flour and various blends was determined organoleptically. The taste panel consisting of 10 members drawn from the student/staff of Institute of Food Technology . The panelists were asked to evaluate the bread for different sensory attributes namely crust colour, crumb colour, texture, flavour, taste and overall acceptability. Following 9 point hedonic scale was used for sensory evaluation of breads.

Hedonic Scale	Score
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

3.8 Storage study of bread

Optimized barley and defatted soy flour bread were packed in polyethylene pouches. The bread was than evaluated at a time interval of 0, 1, 2, 3 and 6 days. The stored bread was evaluated for texture profile analysis and moisture content and sensory characteristics at room temperature (35-37 ^{0}C) and refrigerator temperature (4^{0}C).

3.9 Statistical Analysis

The data obtained were analyzed statistically using analysis of variance (ANOVA) to find if the differences were significant or not. In case of physical characteristics of wheat flour and sensory parameters of bread, average of replications were determined, as mean with critical difference at 5 % level.

Chapter 4

Results and Discussion

The experimental findings of incorporation of barley flour, defatted soy flour in white flour to produce breads are presented and discussed in this chapter. Incorporation of barley flour and defatted soy flour with white flour to prepare bread was optimized. The effect of blending of barley flour and defatted soy flour with white flour on functional, physical, chemical and sensory characteristics of bread were studied.

The presentation in this chapter is divided in to three sections:

4.1 Physicochemical analysis of white flour, barley flour, defatted soy flour and gluten powder and their blends.

4.2 Effect of blending of barley flour, gluten powder and surface active reagent (sodium stearoly-2-lactylate) on functional, physical, chemical and sensory characteristics of blends and their breads.

4.3 Effect of blending of defatted soy flour, gluten powder and surface active reagent (sodium stearoly-2-lactylate) on functional, physical, chemical and sensory characteristics of blends and their breads.

4.1 PHYSICOCHEMICAL ANALYSIS OF WHITE FLOUR, BARLEY FLOUR, DEFATTED SOY FLOUR AND GLUTEN POWDER

4.1.1 White Flour (Maida)

The proximate composition of white flour (maida), barley flour, defatted soy flour and gluten powder is given in Table- 4.1. Moisture content in white flour was 10.27

percent. **Narayan (1991)** reported similar value (10.26 percent) moisture in refined flour. **Rana (2006) and Singh et al.,(2006)** reported a higher value of moisture (13.24 and 13.3 percent) in wheat flour (Maida), respectively. **Weegels P (1993)** reported much higher range (14-16 percent) of moisture content in patent flour.

The result of protein content (10.14 percent) in white flour in the present investigation are slightly higher to the value (9.84 to 10.09 percent) reported by **Bala et al (2004). Patel and Rao (1996B)** and **Gupta and Singh (2005)** reported lower values of protein (8.5 to 9.06 percent) in white flour. **Galan et al (1991) and Dubey et al (2002)** reported higher value of protein (12.09 to12.35 percent). **Gaines et al., (1994)** evaluated eight commercial soft wheat flour and found protein in the range of 6.9 to 10 percent.

The value of fat content (0.68 percent) in white flour in the present investigation was found to be lower than the values (0.82 to 0.87percent) reported by **Bala et al (2004). Singh et al (1989), Dubey et al (2002)** and **Gupta and Singh (2005)** reported higher values (1.60 to 1.90 percent) of fat content in white flour. **Dogra et al., (2004)** reported 0.91 percent fat in white flour. **Mishra et al., (1991)** and **Ballester et al.,(2004)** reported still higher value of fat (1.26%) and (1.5%) in UP-319 variety and wheat flour, respectively.

Ash content in white flour obtained in the present studies was 0.58 percent which was quite similar to the range (0.52 to 0.62 percent) for three different flour reported by **Bala et al. (2004) . Patel and Rao (1996b)** and **Gaines et al., (1994)** reported lower ash content in the range of 0.41 to 0.53 percent. **Dubey et al (2002) and Rana (2006)**

reported slightly higher the range (0.65 to 0.68 percent) of ash content for three different flours. The higher ash content 0.76 percent was reported by **Galan et al., (1991).**

The value of crude fibre content in white flour in the present investigation was 0.29 percent which was quite lower than the values (0.45 to 0.70 percent) found by **Galan et al., (1991), Dubey et al., (2002)** and **Rana (2006).**

In the present investigation the carbohydrate content (calculated by difference) in the white flour was 78.04 percent. **Dubey et al (2002) and Rana (2006)** reported higher values (84.55 percent) of carbohydrate, however **Dogra et al.,(2004)** indicated much higher values (86.07 percent) of carbohydrate content.

The pigment content in white flour was 2.16 ppm. The values of pigment in white flour were in the range (1.96 to 2.41 ppm) reported by **Bala et al., (2004). Gupta et al (1970)** reported the pigment content in fresh white flour was less then 2 ppm. The xanthophylls are converted in to carotene increasing the pigment content. This may be the reason for pigment content in the flour used for present study.

The wet and dry gluten content in white flour were 30.20 and 9.36 percent, respectively. **Patel** and **Rao (1995)** and **Bala et al. (2004)** observed the wet and dry gluten content in the range of 27.07 to 30.40 percent and 10.13 to 11.20 percent, respectively. **Gupta and Pingale (1970)** reported lower value (6.4 to 9.5 percent) of dry gluten in whole wheat flour. Barley and soy flour were devoid of gluten content in the present study.

Table no-4.1 Physicochemical characteristics of white flour (maida), barley flour, soy flour (defatted) and gluten powder

Constituent	White flour	Barley flour	Defatted Soy flour	Gluten powder
Moisture (%)	10.27	10.89	5.48	7.05
Protein (%)	10.14	10.40	45.1	72.5
Fat (%)	0.68	1.42	0.87	0.70
Ash (%)	0.58	1.12	5.12	1.02
Crude Fibre (%)	0.29	3.65	3.80	-
Carbohydrate (by difference)	78.04	72.52	39.63	-
Pigment (ppm)	2.165	2.276	2.69	
Gluten (%) Wet	30.20	-	-	
Gluten (%) Dry	9.36	-	-	
Calcium (mg/100g)	30.0	26.30	251.4	
Phosphorus (mg/100g)	138.0	290.0	493.0	
Iron (mg/100g)	2.48	2.40	10.30	

Values are average of three determinations

The results of present studies showed that white flour contained 30.0 mg/100g calcium, 138.0 mg/100g phosphorus and 2.48 mg/ 100 g iron. The values of calcium content are in the range (17.03 to 31.5 mg/100g) reported by **Bala et al. (2004).** The values of phosphorus content are higher than range (108.6 to 129.7 mg/ 100g) reported by **Bala et al. (2004).** The values of iron content are found lower than the range (9.78 to 11.60 mg/100g) reported by **Bala et al (2004)**. An almost similar result for iron (2.46 mg/100g) was reported by **Rana (2006)** in white flour.

The variation in the proximate compositional constituents may be due to varietal difference, cultivation practices, region of cultivation and level of refining.

4.1.2 Barley Flour

The proximate composition of barley flour is given in Table – 4.1. Moisture content in barley flour was 10.89 percent. **USDA National Nutrient Databased for Standard Reference (2006)** reported a higher value of moisture (12.11 percent) in barley flour.

The result of protein content in barley flour (10.40 percent) in the present investigation was almost similar to the value (10.50 percent) reported by **USDA National Nutrient Data based for Standard Reference (2006). Ereifej et al.,(2006)** reported high values of protein (11.20 and 16.20 percent) in different varieties of barley flour.

The value of fat content (1.42 percent) in barley flour in the present studies was found to be lower than the values (1.60 percent) reported by **USDA National Nutrient Data based for Standard Reference (2006). Brigid Mc Kevith (2004) and Ereifej et**

al.,(2006) indicated a higher range of fat content (1.6 and 5.0 percent) in different varieties of barley flour.

The values of ash content (1.12 percent) in barley flour in the present investigation was lower than the value (1.28 percent) reported by **USDA National Nutrient Databased for Standard Reference (2006).** A range (0.5 to 4.7 percent) for ash content in different varieties of barley flour was reported by **Ereifej et al., (2006).**

The crude fibre content of barley flour was 3.65 percent which was in the range (0.4 to 9.5 percent) reported by **Ereifej et al.,(2006). USDA National Nutrient Data based for Standard Reference (2006)** reported 4.46 percent crude fiber in barley flour.

In the present investigation the carbohydrate content (calculated by difference) in the barley flour was 72.52. **USDA National Nutrient Databased for Standard Reference (2006)** reported slightly higher value of carbohydrate (74.52 percent) in barley flour and 68.6 to 86.4 percent in different varieties of barley flour reported by **Ereifej et al.,(2006).**

The pigment content of barley flour was 2.27 ppm. The xanthophylls are converted in to carotene increasing the pigment content. This may be the reason for pigment content in the flour used for present study.

The barley flour contained 26.30 mg/100g calcium, 290 mg/100g phosphorus and 2.40 mg/100gm iron. Barley flour sample studied by **USDA National Nutrient Data**

based for Standard Reference (2006) had higher value of calcium (32.0 mg/100gm) and phosphorus (296 mg/100gm). **Brigid Mc Kevith (2004)** reported slightly higher values (3.0 mg/100 g) of iron in barley pearls raw. **USDA National Nutrient Databased for Standard Reference (2004)** reported 2.680 mg/100 iron content in barley flour.

The variation in the proximate composition of barley flour may be due to varietals difference, cultivation practices, region of cultivation and refining conditions.

4.1.3 Defatted Soy Flour

The moisture content of defatted soy flour in the present studies was found 5.48 percent. **Circle and Smith (1972)** reported a higher value of moisture (7.0 percent) in defatted soy flour. **Gupta (2006)** reported a lower value of moisture (5.0 percent).

In the present investigation the protein content was found 45.1 percent which was lower than the value (57.1 percent) reported by **Rawat et al., (1994). Dogra et al., (2004)** reported lower value of protein (41.73 percent) in defatted soy flour.

The fat content in defatted soy flour was found to be 0.87 percent. **Mittal et al., (1994)** reported lower value (0.7 percent) of fat in defatted soy flour. **Circle and Smith (1972)** reported slightly higher value of fat content (0.90 percent) in defatted soy flour.

The percentage of ash content in defatted soy flour was 5.12. **Dogra et al., (2004) and Circle and Smith (1972)** reported higher values 11.09 and 6.4 percent for ash content in defatted soy flour, respectively.

The values of crude fibre content in defatted soy flour (3.8 percent) in the present studies was quite lower than the values (4.78 percent) reported by **Dhaliwal et al., (2004). Rawat et al., (1994)** reported lower value (3.4 percent) of crude fiber in defatted soy flour.

The result presented in Table 4.1, showed that the carbohydrate content was 39.63 percent in defatted soy flour. **Rawat et al., (1994)** reported lower value (31.4 percent) of carbohydrate in defatted soy flour.

The result presented in Table 4.1, showed that the pigment content was 2.69 ppm in defatted soy flour. The xanthophylls are converted in to carotene increasing the pigment content. This may be the reason for pigment content in the flour used for present study.

The results of the present studies reported that defatted soy flour contained calcium (251.4 mg/100g), phosphorus (493 mg/100g) and iron (10.30 mg/100g). **Anita Rawat et al (1994)** reported higher value of calcium (311mg/100gm), phosphorus(698 mg/100gm) and iron (16.0 mg/100gm). The difference in mineral content of defatted soy flour may be due to variation in agro- climatic condition and varietal differences.

The variation in the values of proximate compositional principles may be due to the variation in agro climatic condition, varietal difference and variation in cultivation practices.

4.1.4 Gluten Powder

The proximate composition of gluten powder is given in Table- 4.1. Moisture content in gluten powder was 7.05 percent. **Kaur et al., (2006)** reported higher value of moisture (7.60 percent) in Indian gluten powder.

The value of protein content (72.7 percent) in gluten powder obtained in the present investigation was lower than the values (76.70 percent) reported by **Kaur et al., (2006)** in Indian gluten powder.

The result of fat content (0.70 percent) in gluten powder in the present investigation was lower than the values (0.96 percent) in Indian gluten powder reported by **Kaur et al., 2006.**

The ash content in gluten powder was observed 1.02 percent. However, **Kaur et al (2006)** reported slightly higher values (1.16 percent) for ash content in gluten powder.

The variation in proximate composition of gluten powder may be because of the variation in method of preparation.

4.2 EFFECT OF BLENDING OF BARLEY FLOUR, GLUTEN POWDER AND SURFACE ACTIVE REAGENT (Sodium Sterol-2- Lacterol) ON FUNCTIONAL, PHYSICAL, CHEMICAL AND SENSORY CHARACTERISTICS OF BLENDS AND THEIR BREADS

4.2.1 Effect of Blending on Functional Characteristics of Flour and Blends

The physical characteristics like sedimentation value, polenshke value, water absorption, wet gluten, dry gluten and wet/ dry ratio of barley flour blends were presented in Table -4.2.

The results revealed that the sedimentation value of white flour (30.25 ml) was higher than barley flour (26.78 ml). The incorporation of barley flour in white flour at 5, 10, 15 and 20 percent level produced a gradual decrease in sedimentation value of blends and the decrease in sedimentation value was significant ($P \leq 0.05$). **Dhingra** and **Jood (2006)** reported similar decrease in sedimentation value 33.12 to 30.0 ml with incorporation of barley flour (5 to 20 percent) in white flour.

The polenshke value for white flour and barley flour were 126.0 minutes and 102.0 minutes, respectively. There was a gradual decrease in polenshke value with incorporation of barley flour (5 to 20 percent) in white flour from 122.0 to 107.0 minutes and the decrease in polenshke value was significant ($P \leq 0.05$). The polenshke value of white flour might be higher than barley flour as it has higher amount of gluten content.

The value of water absorption for white flour and barley flour were 60.20 and 71.08 percent, respectively. The water absorption values increased form 62.45 to 69.30

percent in blends with incorporation of barley flour in white flour from 5 to 20 percent level and the increase was significant ($P \leq 0.05$). This increase might be due to more retention of water by barley flour in the blends. The water absorption value of barley flour might be higher than white flour because of the higher amount of crude fiber in barley flour. **Dhingra** and **Jood (2006)** reported similar trend in increase in the value of water absorption capacity for control white flour 70.00 percent and 71.80 to 80.70 percent for blended with 5 to 20 percent barley flour. However, values of water absorption capacity of white flour and barley flour were higher than the values obtained in the present investigation. The variation might be due to the varietal difference, agroclimatic condition and method of determination.

The wet and dry gluten content of white flour were 30.20 percent and 9.36 percent, respectively. The result presented in Table-4.2, revealed that the incorporation of barley flour in white flour from 5 to 20 percent decreased proportionately the wet gluten value from 29.0 to 25.40 percent. The decrease was significant ($P \leq 0.05$). **Jood et al., (2004)** reported similar trend of decrease in wet gluten from 28.33 to 22.57 percent by inclusion of barley flour (5 to 20 percent) in white flour.

The incorporation of barley flour from 5 to 20 percent in white flour decreased proportionately the value of dry gluten from 9.36 to 7.49 percent and the decrease was significant ($P \leq 0.05$). **Jood et al. (2004)** reported similar trend of decrease in dry gluten percent by inclusion of barley flour (5 to 20 percent) in white flour.

Table no- 4.2 Effects of blending on functional characteristics of flour and blends

WF:BF	Sedimentation value (ml)	Polenshke value(minuts)	Water absorption (%)	Wet gluten (gm/100g)	Dry gluten (gm/100g)	Wet/Dry ratio
100:00	30.25	126.00	60.20	30.20	9.36	3.226
95:05	29.90	122.00	62.45	29.00	8.93	3.247
90:10	29.50	117.00	64.73	27.78	8.48	3.275
85:15	28.80	112.00	67.02	26.59	7.97	3.336
80:20	28.11	107.00	69.30	25.40	7.46	3.404
00:100	26.78	102.00	71.08	-	-	-
Mean	28.89	114.30	65.79	27.79	8.44	3.297
CD at 5% Level	0.270	1.99	1.35	0.33	0.19	0.112

Values are average of three determinations

The value of wet/dry ratio of gluten in white flour was 3.226. The results of present investigation indicated that the blending of barley flour with white flour increased wet/dry ratio of gluten in blends with increase in level of barely flour (5-20 percent).The increase in wet/dry ratio up to 15 percent was non significant after that a significant ($P \leq 0.05$) increase in wet/dry ratio was observed.

4.2.2 Effect of Blending on Chemical Composition of White Flour and Barley Flour Blends

The result of the effect of blending of barley flour with white flour on chemical composition such as protein, fat, ash, crude fiber, carbohydrate, calcium, iron and phosphorus content of white flour are presented in Table 4.3.

The protein content of white and barley flour were 10.14 and 10.40 percent, respectively. The incorporation of barley flour in white flour proportionately increased the protein content from 10.16 to 10.40 percent and the increase was non significant upto 15% level and thereafter a significant ($P \leq 0.05$) increase was observed. The increase in protein content was attributed to higher value of protein content in barley flour.

The fat content for white flour and barley flour were 0.68 and 1.42 percent, respectively. The fat content increased gradually with incorporation of barley flour (5 to 20 percent) in white flour from 0.71 to 0.83 percent. The increase in fat content up to 5 percent incorporation of barley flour was non-significant thereafter a significant ($P \leq 0.05$)

increase was observed. The increase in fat content was attributed to higher value of fat content in barley flour. **Dhingra** and **Jood (2006)** reported similar increase in fat content with incorporation of barley flour (5 to 20%) in white flour.

The value of ash content in white flour and barley flour were 0.58 and 1.12 percent, respectively. The incorporation of barley flour (5-20%) in white flour produced a gradual increase in ash content of blends from 0.60 to 0.69 percent and the increase up to 5 percent was non significant, thereafter the variation was significant ($P \leq 0.05$). The increase in ash content was attributed to higher value of ash content in barley flour. **Dhingra** and **Jood (2006)** reported similar increase in ash content with incorporation of barley flour.

From the results presented in Table- 4.3, it is revealed that the crude fibre content was lowest (0.29 percent) in white flour and highest (3.65 percent) in barley flour. There was a gradual increase in crude fibre content (0.46 to 0.96 percent) with incorporation of barley flour (5 to 20 percent) in white flour and the increase in crude fibre was significant ($P \leq 0.05$). The increase in values of crude fibre in blended flour was due to higher amount of crude fibre in barley flour.

In the present study, the value of carbohydrate content in white flour and barley flour were 88.31 and 72.52 percent, respectively. The blending of barley flour with white flour decreased the carbohydrate content from 87.52 to 74.27 percent with increase in barley flour from 5 to 20 percent, respectively and the decrease in carbohydrate content

was significant (P≤0.05). The decrease in carbohydrate content was due to increase in protein, fat, ash and crude fibre in blends.

The calcium content of white flour and barley flour were 30.10 mg/100 and 26.30 mg/100 gm (Table 4.3). The result revealed gradual decrease(29.91 to 25.29 mg/100g) in calcium content with blending of barley flour from 5 to 20 percent in white flour and the decrease in calcium content was non significant upto 5% inclusion of barley flour and thereafter a significant (P≤0.05) variation was observed. **Dhingra** and **Jood (2006)** reported similar decrease in calcium content in blends by incorporation of barley flour in white flour.

The results showed an increase in phosphorus content of composite flour made up of white flour and barley flour. The value of phosphorus content in white flour and barley flour were 138.0 and 168.40 (mg/100g.). The phosphorus content increased proportionately 145 to 168.40 mg/100gm in blends with incorporation of barley flour (5 to 20 percent) in white flour and the variation was significant (P≤0.05). **Jood et al.,(2006)** reported similar increase in phosphorus content in the blends (barley flour in white flour).

The result revealed slight decrease in iron content of blends (white flour and barley flour). The maximum iron content was 2.48 (mg/100gm.) in white flour and minimum 2.4 (mg/100gm.) in barley flour. There was a non significant variation in iron content in blends up to15 percent incorporation of barley flour, thereafter a significant (P≤0.05) variation was observed. **Dhingra et al (2006)** reported similar increase in iron content in the blends.

Table no-4.3 Effect of blending on chemical composition of white flour and barley flour blends

WF:BF	Protein %	Fat %	Ash %	Crude fiber %	Carbohydrate %	Calcium (mg/100 g)	Phosphorus (mg/100 g)	Iron (mg/100 g)
100:00	10.14	0.68	0.58	0.29	88.31	30.10	138.00	2.48
95:05	10.16	0.71	0.60	0.46	87.52	29.91	145.00	2.47
90:10	10.18	0.75	0.63	0.63	83.10	29.72	153.20	2.46
85:15	10.21	0.79	0.66	0.79	78.69	29.53	160.80	2.45
80:20	10.24	0.83	0.69	0.96	74.27	29.34	168.40	2.44
00:100	10.40	1.42	1.12	3.65	72.52	26.30	290.00	2.40
Mean	10.22	0.86	0.72	1.13	80.74	29.15	175.80	2.46
CD at 5% Level	0.07	0.03	0.02	0.09	0.51	0.60	3.22	0.03

Values are average of three determinations

4.2.3 Physical Characteristic of Bread (baking characteristics)

4.2.3.1 Effect of incorporation of barley flour level on physical characteristics

The results of the effect of barley flour incorporation on physical characteristics of breads are presented in Table- 4.4. The results revealed a proportionate increase in loaf weight of barley incorporated bread with increase the level of barley flour (5-20%) and the increase was significant ($P \leq 0.05$). The increase in loaf weight with increase in the levels of barley flour might be because of the increase in retention of extra amount of water in breads after baking and less retention of gas in the blended dough, hence providing denser bread texture. The results of present investigation are in close conformity to the results reported by **Ereifej & Shibli, 1993; Sharma & Chauhan, 2000** and **Dhingra et al (2004).**

The results presented in Table- 4.4 revealed a significant ($P \leq 0.05$) reduction in loaf volume of bread with incorporation the level of barley flour (5 to 20 %) in white flour. The highest reduction in loaf volume was in bread made from 20% barley blended flour. It might be due to a dilution effect on gluten with addition of barley flour and less retention of CO_2 gas caused the depression in loaf volume **(Ereifej & Shibli, 1993; Sharma & Chauhan, 2000**. Almost similar values for loaf volume were reported by **Dhingra et al (2004).**

The specific loaf volume is obtained by dividing the loaf volume by loaf weight and results revealed a gradual decrease in specific loaf volume of bread with increase in level of barley flour (5 to 20 percent) in bread. The value of specific loaf volume was highest (3.21 mlg^{-1}) for control sample and lowest (2.95 mlg^{-1}) for 20 percent barley

Table no- 4.4 Effect of incorporation of barley flour on the physical characteristics of bread

Proportion of BF (%)	Loaf weight (gm)	Loaf volume (ml)	Specific loaf volume (mlg^{1})	Slice height (cm)	Loaf height (cm)	Compression force (TPA) in kg
0	160.20	515.00	3.21	6.93	7.23	2.455
5	161.70	510.20	3.15	6.69	6.83	3.265
10	163.78	504.23	3.07	6.42	6.46	3.983
15	165.88	498.00	3.00	6.18	6.20	4.478
20	167.40	494.55	2.95	5.80	5.91	6.212
Mean	163.79	504.39	3.08	6.40	6.53	4.078
CD($P \leq 0.05$)	1.25	3.47	0.03	0.14	0.21	0.650

Values are average of three determinations

Incorporated bread. There was a significant ($P \leq 0.05$) decrease in specific loaf volume with incorporation of barley flour. The poor quality and quantity of gluten in barley flour blended breads may be responsible for retention of CO_2 gas in the fermented dough and lower specific loaf volume. Similar observations have been reported by **Indrani & Rao (1992)**, **Ereifej & Shibli (1993) and Dhingra et al.,(2004).**

The results revealed a gradual decrease in slice height with increase the level of barley flour in bread. The value for slice height was maximum (6.93 cm) for control bread and minimum (5.80 cm) for 20 percent barley flour incorporated bread. There was a significant ($P \leq 0.05$) decrease in slice height of bread with increase the level of barley flour in white flour. The decrease in slice height might be because of dilution of gluten with addition of barley flour in white flour as a result of which less retention of CO_2 gas and lower increase in volume.

The results showed a gradual decrease in loaf height of bread with increase the level of barley flour in white flour. The loaf height of bread decreased from 7.23 cm (control) to 5.91 cm in barley flour (20 percent) incorporated bread. There was a significant ($P \leq 0.05$) decrease in loaf height of bread with increase in level of barley flour. The reduction in loaf height of bread was due to the decrease in loaf volume of bread brought by reduced gluten content in blends and hence less retention of CO_2 gas.

The results indicated an increase in the value of compression force (in kg) with increase in barley flour level in bread (Table - 4.4). The values for compression force

were in the range of 2.455 kg to 6.212 kg. The maximum value of compression force was observed for 20 percent barley flour incorporated bread while the minimum value was reported for the control bread. The statistical analysis revealed a significant ($P \leq 0.05$) increase in compression force of bread with increasing the level of barley flour. An increase in compression force was due to the hard texture of bread, which might be due to the decrease in gluten percent with increase of barley flour in blends.

4.2.3.2 Effect of gluten powder level on physical characteristics of barley flour incorporated bread

The results showing the effect of inclusion of gluten powder on the loaf weight, loaf volume, specific loaf volume, slice height, loaf height and compression force (T PA) of barley flour incorporated bread are presented in Table- 4.5. The results revealed a gradual increase in loaf weight of bread from 165.88 to 167.15 (gm) with increase in gluten powder level from 0 to 8 percent. The loaf weight of barley flour incorporated bread increased proportionately and the variation was significant ($P \leq 0.05$). The increase in loaf weight might be due to more absorption of water because of increase in the level of gluten.

The loaf volume of bread increased from 498.0 to 502.98 ml with increase in gluten powder from 0 to 8 percent, respectively. The increase in loaf volume was insignificant up to 4 percent increase in gluten powder and thereafter it was significant ($P \leq 0.05$). **Kaur et al.,(2006)** also reported an increase in loaf volume of bread with 10

percent increase of Indian gluten powder. The increase in loaf volume may be due to the increase in puffiness of loaf because of more production and retention of gases liberated during fermentation and baking.

The results revealed a proportionate increase in specific loaf volume of barley flour incorporated bread ranged from 3.00 to 3.009 mlg^{-1} on increasing in gluten powder from 0 to 8 percent and the increase in specific loaf volume was non significant.

The results revealed an increase in the slice height from 6.18 to 6.32 cm with increasing level of gluten powder from 0 to 8 percent. The increase in slice height of bread was found significant ($P \leq 0.05$) with increase in gluten powder level in bread.

From the Table- 4.5, it was observed that the inclusion of gluten powder showed a proportionate increase in loaf height. The results showed that the loaf height was lowest value (6.20 cm) for control sample and highest (6.38 cm) with 8 percent gluten powder. The increase in loaf height was significant ($P \leq 0.05$) with increase in gluten powder level.

Table no-4.5 Effect of gluten powder level on physical characteristics of barley flour incorporated bread

Proportion of GP (%)	Loaf weight (gm)	Loaf volume (ml)	Specific loaf volume (mlg^{1})	Slice height (cm)	Loaf height (cm)	Compression force (TPA) in kg
0	165.88	498.00	3.000	6.18	6.20	4.478
2	166.20	498.98	3.002	6.21	6.24	3.927
4	166.52	500.06	3.003	6.24	6.30	3.322
6	166.75	501.02	3.004	6.28	6.34	2.869
8	167.15	502.98	3.009	6.32	6.38	2.319
Mean	166.50	500.20	3.003	6.24	6.29	3.383
CD at 5% level	0.24	2.10	0.012	0.02	0.03	0.321

Values are average of three determinations

The results of effect of gluten incorporation on texture of barley flour included bread shown in Table- 4.5, revealed a proportionate decrease in hardness and the decrease in hardness was significant ($P \leq 0.05$). The compression force was maximum 4.478 (kg) in control sample and the compression force decreased from 4.478 to 2.319 (kg) with increase in gluten powder level from 0 to 8 percent, respectively.

The increase in loaf weight, loaf volume, specific loaf volume, slice height, loaf height and decrease in hardness might be due to the increase in puffiness of loaf because of more production and retention of gases liberated during fermentation and baking with enhanced level of gluten in barley included bread.

4.2.3.3 Effect of surface active reagent level (Sodium Stearoly 2-Lactylate) on physical characteristics of barley flour incorporated bread

The results showing the effects of surface active reagent on loaf weight, loaf volume, specific loaf volume, slice height, loaf height and compression force of barley flour incorporated bread are presented in Table- 4.6.

From the results it is revealed that the weight of bread slightly increased form 166.90 to 167.30 gm. The increase in surface active reagent (SSL) level showed an increase in loaf weight on increasing the flour improver level from 0.00 to 2.0 percent and the variation was significant ($P \leq 0.05$). **Kaur et al., (2006)** also reported an increase in loaf weight with incorporation of 10 percent Indian gluten powder and 0.50 percent

surface active reagent (SSL) in bread. The increase in loaf weight might be due to increase in absorption of water because of addition of flour improver.

The addition of surface active reagent (SSL) 0.5 to 2.0 percent revealed an increase in loaf volume on increasing surface active reagent level and the enhancement was significant ($P \leq 0.05$). **Kaur et al., (2006)** also reported increase in loaf volume by incorporation of 10 percent Indian gluten powder and 0.50 percent surface active reagent (SSL) in bread. The increase in loaf volume might be due to better retention of gases in bread during fermentation and baking because of addition of surface active reagent (SSL)

The results showed an increase in specific loaf volume with increase in the level of surface active reagent (SSL). The specific loaf volume increased from 3.003 to 3.010mlg^{-1} with increase in surface active reagent level from 0.50 to 2.0 percent. The increase in specific loaf volume of bread was significant ($P \leq 0.05$) with increase the level of surface active reagent in bread.

The results revealed a slight increase in slice height of bread on increasing surface active reagent (SSL) level from 0.50 to 2.0 percent. The slice height of control bread sample was minimum 6.28 cm control sample and maximum (6.42 cm) of 2.0 percent surface active reagent (SSL) added bread sample. The increase in slice height of bread was found non significant upto 1.5 percent level of surface active reagent (SSL) thereafter a significant ($P \leq 0.05$) increase was observed.

Table no-4.6 Effect of surface active reagent level (SSL) on physical characteristics of barley flour fortified bread

Proportion of SAR (%)	Loaf weight (gm)	Loaf volume (ml)	Specific loaf volume (mlg^{-1})	Slice height (cm)	Loaf height (cm)	Compression force (TPA) in kg
0	166.90	501.35	3.003	6.28	6.34	2.869
0.5	166.98	501.92	3.005	6.31	6.38	2.673
1	167.07	502.49	3.007	6.35	6.42	2.532
1.5	167.15	503.00	3.009	6.39	6.46	2.310
2	167.30	503.67	3.010	6.42	6.50	1.992
Mean	167.08	502.48	3.006	6.35	6.42	2.475
CD($P\leq0.05$)	0.05	0.24	0.001	0.11	0.12	0.136

Values are average of three determinations

The results showed an increasing trend in loaf height of barley flour incorporated bread on increasing the level of surface active reagent (SSL). The value of loaf height increased from 6.38 to 6.50 cm. on increasing of surface active reagent (SSL) from 0.50 to 2.0 percent. The increase in loaf height of bread was found non significant up to 1.5 percent level of surface active reagent thereafter a significant ($P \leq 0.05$) variation was found. **Kaur et al., (2006)** also reported similar result on adding the surface active reagent (SSL) in bread.

The results of texture profile analysis of barley flour fortified bread showed decrease in hardness on increasing the level of surface active reagent (SSL). The value of hardness was maximum (2.869 kg) for control and minimum (1.992 kg) for 2.0 percent surface active reagent (SSL) level. The decrease in hardness was significant ($P \leq 0.05$) with increase in surface active reagent (SSL) level.

The increase in loaf weight, loaf volume, specific loaf volume, slice height, loaf height and decrease in hardness might be due to the increase in puffiness of loaf because of more production and retention of gases during fermentation and baking with enhanced level of surface active reagent (SSL) and gluten in barley included bread.

4.2.4 Chemical composition of white flour and barley flour incorporated bread

The results of chemical composition (moisture, protein, fat, ash, crude fiber, carbohydrate, calcium, phosphorus and iron) of white bread and barley flour incorporated

bread are presented in Table- 4.7. Barley flour was incorporated in bread from 5 to 20 percent level.

The moisture content of bread increased from 30.60 to 35.20 percent with incorporation of barley flour from 0 to 20 percent. The increase in moisture content was significant ($P \leq 0.05$). The increase in moisture content of barley flour incorporated bread might be due to more amount of crude fiber in barley which absorbed more moisture. Similar results were obtained by **Balleste et al., (1988)** who reported an increase in moisture content from 36.0 to 37.5 percent with incorporation of sweet lupin flour (6 to 12 percent) in white flour.

The protein content decreased proportionately from 9.64 to 8.80 percent with increase in barley flour from 0 to 20 percent. The decrease in protein content was significant ($P \leq 0.05$) .similar results were obtained by **Dhingra** and **Jood (2006)** who reported a decrease in protein content in bread fortified with barley flour.

From the result presented in Table- 4.7, it is revealed that the fat content of bread increased proportionately from 0.69 to 0.92 percent with increase in barley flour from 0 to 20 percent in bread. The increase in fat content was significant ($P \leq 0.05$). **Dhingra** and **Jood (2006)** also observed an increase in fat content of bread fortified with barley flour (5 to 20 percent).

Table no-4.7 Chemical composition of white flour and barley flour incorporated bread

WF:BF	Moisture%	Protein %	Fat %	Ash %	Crude fiber %	Carbohydrate %	Calcium (mg/100 g)	Phosphorus (mg/100 g)	Iron (mg/100 g)
100:00	30.6	9.64	0.69	0.58	0.28	58.21	30.10	137.00	2.48
95:05	31.82	9.56	0.74	0.61	0.33	56.94	29.79	143.00	2.47
90:10	33.02	9.30	0.79	0.64	0.37	55.88	28.39	149.00	2.46
85:15	34.11	9.04	0.85	0.67	0.42	54.91	26.95	156.00	2.45
80:20	35.2	8.80	0.92	0.70	0.47	53.91	25.35	163.00	2.44
Mean	32.95	9.27	0.79	0.64	0.37	55.97	28.11	149.00	2.46
CD at 5% Level	0.43	0.06	0.03	0.03	0.04	0.73	0.30	2.22	0.01

Values are average of three determinations

The ash content was minimum (0.58 percent) for control bread and maximum (0.70 percent) for 20 percent barley included bread. The increase was non significant upto 5 percent thereafter a significant ($P \leq 0.05$) increase was observed. **Dhingra** and **Jood (2006)** also reported an increase in ash content of bread blended with barley flour.

In the present study, the crude fiber content in control bread was 0.29 percent. Incorporation of barley flour was increased 0.29 to 0.47 percent crude fiber on increasing 0 to 20 percent level of barley flour. The increase in crude fiber content was significant ($P \leq 0.05$). **Dhingra** and **Jood (2006)** reported similar increasing trend in crude fiber of bread fortified with 5 to 20 percent barley flour.

The results revealed a gradual decrease in carbohydrate content of barley flour incorporated bread with increase in the amount of barley flour and the decrease was significant ($P \leq 0.05$). Control bread had 58.20 (percent) carbohydrate content and 20 percent barley bread had (53.93 percent).

In the present study, the calcium content in control bread was 30.10 mg/100gm. Incorporation of barley flour decreased 30.10 to 25.35mg/100gm calcium on increasing 0 to 20 percent barley flour in bread. There was a significant ($P \leq 0.05$) decrease in calcium content on increasing the level of barley. **Dhingra** and **Jood (2006)** reported similar decreasing trend in calcium content of bread included with 5 to 20 percent barley flour.

The phosphorus content was minimum 137.0 mg/100gm for control bread and maximum 163.0 mg/100gm for 20 percent barley flour incorporated bread. The increase was significant ($P \leq 0.05$). **Dhingra** and **Jood (2006)** also reported similar increasing trend in phosphorus content of bread included with 5 to 20 percent barley flour.

The iron content in control bread was 2.48 mg/100gm and in 20 percent barley bread was (2.44mg/100gm).The results revealed a gradual decrease in iron content of barley flour incorporated bread on increasing the level of barley flour and the decrease was significant ($P \leq 0.05$).

4.2.5 Organoleptic characteristics of bread prepared from blends

4.2.5.1 Effect of barley flour on sensory characteristics of bread

The barley flour incorporated breads were evaluated for their sensory characteristics using a taste panel consisting of ten untrained members of Institute of Food Technology. The panelists were asked to evaluate the product for crust colour, crumb colour, grain size (texture), taste, flavour and over all acceptability. A 9- point hedonic scale was used for the sensory evaluation of bread and results were analyzed, using analysis of variance (ANOVA). The mean sensory scores for crust colour, crumb colour, grain colour, taste, flavour and over all acceptability of bread made from blending of barley flour in white flour were presented in Table- 4.8 to 4.13, respectively.

Effect of blending of barley flour on sensory characteristics of bread

Table no-4.8 Sensory score of crust colour of barley fortified flour incorporated bread

Panelists	Proportion of barley flour				
	0	**5**	**10**	**15**	**20**
1	8.12	8.05	7.97	7.89	6.15
2	8.26	8.16	8.05	7.94	6.26
3	8.30	8.23	8.17	8.06	6.32
4	8.22	8.13	8.03	7.94	6.22
5	8.10	7.98	7.84	7.79	6.09
6	8.32	8.23	8.13	8.04	6.30
7	8.19	8.10	8.00	7.91	6.20
8	8.05	7.91	7.88	7.75	6.09
9	8.22	8.13	8.03	7.94	6.22
10	8.12	8.08	7.90	7.85	6.14
Mean	8.19	8.1	8	7.91	6.2
CD at 5% level	0.32				

Table no-4 .9 Sensory score of crumb colour of barley fortified flour incorporated bread

Panelists	Proportion of barley flour				
	0	**5**	**10**	**15**	**20**
1	8.02	7.95	7.89	7.77	5.75
2	8.16	8.06	7.97	7.82	5.85
3	8.20	8.13	8.08	7.93	5.90
4	8.12	8.03	7.95	7.82	5.81
5	8.00	7.88	7.76	7.68	5.69
6	8.22	8.13	8.05	7.91	5.88
7	8.09	8.00	7.92	7.79	5.79
8	7.95	7.81	7.80	7.63	5.68
9	8.12	8.03	7.95	7.82	5.81
10	8.02	7.98	7.82	7.73	5.73
Mean	8.09	8	7.92	7.79	5.79
CD at 5% level	0.31				

The result presented in Table- 4.8, indicated a decreasing trend in crust colour of bread with increase in level of barley flour. However, the decrease in crust colour up to 15 percent was non significant thereafter a significant ($P<0.05$) decrease in crust colour was observed. The bread produced by incorporation of barley flour up to 20 percent was in the acceptable range for crust colour.

The results presented in Table- 4.9, indicated a decreasing trend in mean sensory score of crumb colour of bread on increasing the level of barley flour upto 20 percent. However, the decrease up to 15 percent was non significant thereafter the variation was significant ($P\leq 0.05$). The mean crumb colour scores for barley flour incorporated bread was in acceptable range up to 15 percent level. **Dhingra et al (2004)** reported similar results for variation in crumb colour.

From the results presented in Table 4.10, it is revealed that a decreasing trend in the mean scores of texture of bread on increasing the level of barley flour incorporated bread upto 20 percent level. The bread upto 15 percent level of barley flour was in acceptable range and the variation up to 15 percent was non significant, thereafter the decrease in texture score was significant ($P\leq 0.05$). **Dhingra et al (2004)** reported similar decrease in texture scores form 5 to 20 percent barley flour incorporation

The results presented in Table- 4.11, showed a decrease in mean sensory score for taste of bread with increase in incorporation level of barley flour (0-20 percent). However, the decrease up to 15 percent was non-significant. Thereafter a significant ($P\leq$

Table no 4.10 Sensory score of texture(grain size) of barley fortified flour incorporated bread

Panelists	Proportion of barley flour				
	0	5	10	15	20
1	8.07	8.00	7.84	7.68	5.66
2	8.21	8.11	7.92	7.73	5.76
3	8.25	8.18	8.03	7.84	5.81
4	8.17	8.08	7.90	7.73	5.72
5	8.05	7.93	7.72	7.59	5.60
6	8.27	8.18	8.00	7.82	5.79
7	8.14	8.05	7.87	7.70	5.70
8	8.00	7.86	7.75	7.54	5.60
9	8.17	8.08	7.90	7.73	5.72
10	8.07	8.03	7.77	7.64	5.64
Mean	8.14	8.05	7.87	7.7	5.7
CD at 5%	0.462				

Table no-4. 11 Sensory score of taste of barley fortified flour incorporated bread

Panelists	Proportion of barley flour				
	0	5	10	15	20
1	8.04	8.01	7.92	7.51	5.91
2	8.18	8.12	8.00	7.56	6.01
3	8.22	8.19	8.12	7.67	6.07
4	8.14	8.09	7.98	7.56	5.97
5	8.02	7.94	7.79	7.42	5.85
6	8.24	8.19	8.08	7.65	6.04
7	8.11	8.06	7.95	7.53	5.95
8	7.97	7.87	7.83	7.37	5.84
9	8.14	8.09	7.98	7.56	5.97
10	8.04	8.04	7.85	7.47	5.89
Mean	8.11	8.06	7.95	7.53	5.95
CD at 5%	0.60				

0.05) decrease in variation was observed. The bread with 15 and 20 percent barley flour scored 7.53 and 6.06 respectively. **Dhingra et al (2004)** reported similar decrease in taste scores form 5 to 20 percent barley flour incorporation.

The results presented in Table- 4.12, indicated a decrease in mean sensory score for flavour of bread by increasing the level of barley flour (0-20 percent). However the decrease upto 15 percent was non significant, thereafter a significant (P≤ 0.05) decrease was observed. The bread produced by incorporation of barley flour upto 20 percent was found to be in the acceptable range. **Dhingra et al (2004)** reported similar decrease in flavour scores from 5 to 20 percent barley flour incorporation

From the results presented in Table- 4.13, it is revealed that a decreasing trend was observed in over all acceptability of barley flour incorporated bread by increasing the level of barley flour from0 to 20 percent in white flour. The incorporation of barley flour upto 15 percent showed a non significant difference in the mean of over all acceptability, thereafter a significant (P≤ 0.05) decrease was observed.

On the basis of sensory evaluation, 15 percent incorporation of barley flour was optimized to prepare bread for further studies.

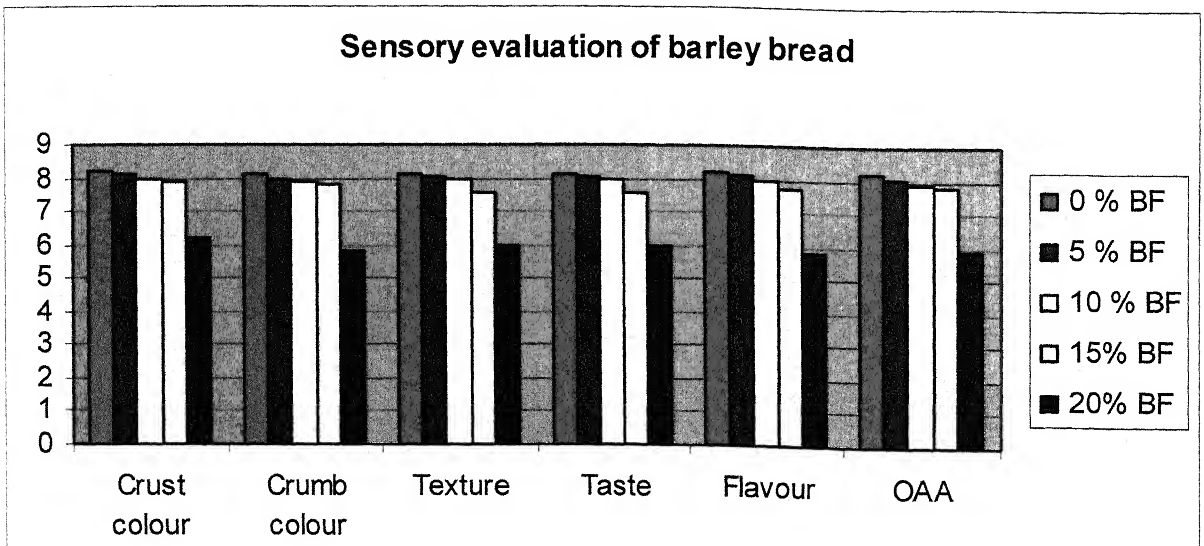

Sensory evaluation of barley bread
9
8
7
6
5
4
3
2
1
0
Crust colour
Crumb colour
Texture
Taste
Flavour
OAA
0 % BF
5 % BF
10 % BF
15% BF
20% BF

Fig no-4.1

Table no-4.12 Sensory score of flavour of barley fortified flour incorporated bread

Panelists	Proportion of barley flour				
	0	5	10	15	20
1	8.14	8.10	7.97	7.73	5.80
2	8.28	8.21	8.05	7.78	5.90
3	8.32	8.28	8.17	7.89	5.95
4	8.24	8.18	8.03	7.78	5.86
5	8.12	8.03	7.84	7.64	5.74
6	8.34	8.28	8.13	7.87	5.93
7	8.21	8.15	8.00	7.75	5.84
8	8.07	7.96	7.88	7.59	5.73
9	8.24	8.18	8.03	7.78	5.86
10	8.14	8.13	7.90	7.69	5.78
Mean	8.21	8.15	8	7.75	5.84
CD at 5%	0.48				

Table no- 4.13 Sensory score of OAA of barley fortified flour incorporated bread

Panelists	Proportion of barley flour				
	0	5	10	15	20
1	8.11	8.01	7.86	7.75	5.86
2	8.25	8.12	7.94	7.80	5.96
3	8.29	8.19	8.05	7.91	6.02
4	8.21	8.09	7.92	7.80	5.92
5	8.09	7.94	7.74	7.66	5.80
6	8.31	8.19	8.02	7.89	5.99
7	8.18	8.06	7.89	7.77	5.90
8	8.04	7.87	7.77	7.61	5.79
9	8.21	8.09	7.92	7.80	5.92
10	8.08	8.05	7.85	7.68	6.36
Mean	8.18	8.06	7.89	7.77	5.9
CD at 5%	0.423				

4.2.5.2 Effect of blending of gluten powder on sensory characteristic of barley incorporated bread

The effect of blending of gluten on sensory characteristics such as crust colour, crumb colour, texture, taste, flavour and over all acceptability of barley flour incorporated bread was given in Table-4.14 to 4.19, respectively.

From the result presented in Table- 4.14, it is revealed that the addition of gluten in barley incorporated bread enhanced the mean sensory score for crust colour and the score was maximum 7.12 with 4 percent inclusion of gluten powder. The control and 2 percent gluten powder added bread were significantly ($P \leq 0.05$) lower in crust colour. Further variation in crust colour of bread with 6 and 8 percent inclusion of gluten powder was non significant with 4 percent included bread.

The results presented in Table-4.15, indicated that the addition of gluten powder showed an increasing trend in the mean sensory score for crumb colour and was maximum (7.18) of the bread prepared with 4 percent addition of gluten powder level. The crumb colour was significantly ($P \leq 0.05$) superior than control and 2percent level of gluten powder. However, 6 percent and 8 percent incorporation of gluten powder showed non significant variation in crumb colour.

From the results presented in Table- 4.16, showed the mean sensory score for texture was maximum (7.34) of the bread prepared with 4 percent inclusion of gluten Powder and was significantly($P \leq 0.05$) superior than control and 2 percent gluten powder inclusion.. However, the variation in texture of 6 and 8 percent of gluten powder included bread was non-significant.

Effect of Gluten Powder on Sensory characteristics of barley flour incorporated bread

Table no-4.14 **Crust Colour**

Panelists	Proportion of Gluten powder in 15 percent barley flour incorporated optimized bread				
	0%	2%GP	4%GP	6% GP	8%GP
1.00	6.57	6.83	7.09	7.06	6.95
2.00	6.69	6.92	7.16	7.11	7.07
3.00	6.72	6.98	7.27	7.21	7.14
4.00	6.65	6.90	7.15	7.11	7.03
5.00	6.56	6.77	6.98	6.98	6.88
6.00	6.74	6.98	7.23	7.19	7.11
7.00	6.63	6.87	7.12	7.08	7.00
8.00	6.52	6.71	7.02	6.93	6.87
9.00	6.65	6.90	7.15	7.11	7.03
10.00	6.57	6.85	7.03	7.03	6.93
Mean	6.63	6.87	7.12	7.08	7.00
CD at 5%	0.14				

Table no-4.15 **Crumb Colour**

Panelists	Proportion of Gluten powder in 15 percent barley flour incorporated optimized bread				
	0%	2%GP	4%GP	6% GP	8%GP
1.00	6.84	6.91	7.15	7.09	7.03
2.00	6.96	7.00	7.22	7.14	7.15
3.00	6.99	7.06	7.33	7.24	7.22
4.00	6.93	6.98	7.21	7.14	7.11
5.00	6.82	6.85	7.04	7.01	6.96
6.00	7.01	7.06	7.29	7.22	7.19
7.00	6.90	6.95	7.18	7.11	7.08
8.00	6.78	6.79	7.07	6.96	6.95
9.00	6.93	6.98	7.21	7.14	7.11
10.00	6.84	6.93	7.09	7.06	7.01
Mean	6.90	6.95	7.18	7.11	7.08
CD at 5%	0.10				

The increase in gluten powder dispersed the protein in the bread and leading to a soft product.

The result presented in Table 4.17, showed that the mean sensory score for taste was maximum (7.30) of the bread prepared with 4 percent inclusion of gluten powder and was significantly ($P \leq 0.05$) superior to control and 2 percent gluten level bread. However, the variation in texture with 6 and 8 percent gluten powder added bread was nonsignificant. The optimum amount of gluten in bread would have to lead the increasing taste score.

The result presented in Table- 4.18, showed that the maximum mean sensory score for flavour (7.13) was obtained at 4 percent gluten powder incorporated bread and the bread with 4 percent gluten was significantly ($P \leq 0.05$) superior than control and 2 percent gluten bread. However, the variation with 6 and 8 percent gluten bread was nonsignificant decreased the mean sensory score of flavour.

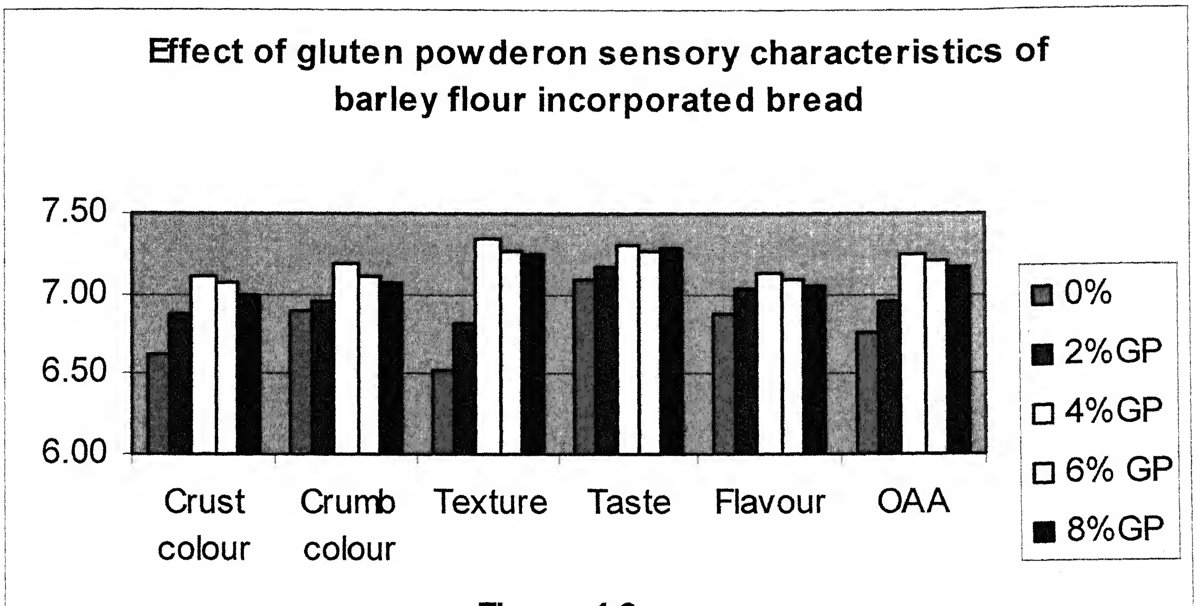
From the result presented in Table-4.19, it is revealed that the mean sensory score of over all acceptability was maximum (7.24) of bread prepared with 4 percent incorporation of gluten powder. The variation with 6 and 8 percent inclusion of gluten powder was nonsignificant and with other combination were significant ($P \leq 0.05$).

Table no- 4.16 **On Texture (grain size)**

Panelists	Proportion of Gluten powder in 15 percent barley flour incorporated optimized bread				
	0%	2%GP	4%GP	6% GP	8%GP
1.00	6.46	6.77	7.31	7.25	7.19
2.00	6.58	6.86	7.38	7.30	7.31
3.00	6.61	6.92	7.49	7.40	7.38
4.00	6.54	6.84	7.37	7.30	7.27
5.00	6.45	6.71	7.20	7.16	7.12
6.00	6.62	6.92	7.46	7.39	7.36
7.00	6.52	6.81	7.34	7.27	7.24
8.00	6.41	6.65	7.23	7.12	7.11
9.00	6.54	6.84	7.37	7.30	7.27
10.00	6.46	6.79	7.25	7.22	7.17
Mean	6.52	6.81	7.34	7.27	7.24
CD at 5%	0.12				

Table no-4.17 **On Taste**

Panelists	Proportion of Gluten powder in 15 percent barley flour incorporated optimized bread				
	0%	2%GP	4%GP	6% GP	8%GP
1.00	7.04	7.13	7.27	7.26	7.21
2.00	7.16	7.22	7.34	7.31	7.33
3.00	7.20	7.28	7.45	7.41	7.40
4.00	7.13	7.20	7.33	7.31	7.29
5.00	7.02	7.06	7.16	7.17	7.14
6.00	7.21	7.28	7.42	7.40	7.38
7.00	7.10	7.17	7.30	7.28	7.26
8.00	6.98	7.00	7.19	7.13	7.13
9.00	7.13	7.20	7.33	7.31	7.29
10.00	7.04	7.15	7.21	7.23	7.19
Mean	7.10	7.17	7.30	7.28	7.26
CD at 5%	0.07				



Effect of gluten powderon sensory characteristics of barley flour incorporated bread
7.50
7.00
6.50
6.00
Crust colour
Crumb colour
Texture
Taste
Flavour
OAA
0%
2%GP
4%GP
6% GP
8%GP

Fig no-4.2

Table no-4.18 On Flavour

Panelists	Proportion of Gluten powder in 15 percent barley flour incorporated optimized bread				
	0%	2%GP	4%GP	6% GP	8%GP
1.00	6.82	6.99	7.10	7.08	7.01
2.00	6.94	7.08	7.17	7.13	7.13
3.00	6.97	7.14	7.28	7.23	7.20
4.00	6.91	7.06	7.16	7.13	7.09
5.00	6.80	6.93	6.99	7.00	6.94
6.00	6.99	7.14	7.24	7.21	7.17
7.00	6.88	7.03	7.13	7.10	7.06
8.00	6.76	6.87	7.03	6.95	6.93
9.00	6.91	7.06	7.16	7.13	7.09
10.00	6.82	7.01	7.04	7.05	6.99
Mean	6.88	7.03	7.13	7.10	7.06
CD at 5%	0.09				

Table no-4.19 Over All Acceptability

Panelists	Proportion of Gluten powder in 15 percent barley flour incorporated optimized bread				
	0%	2%GP	4%GP	6% GP	8%GP
1.00	6.70	6.91	7.21	7.18	7.11
2.00	6.82	7.00	7.28	7.23	7.23
3.00	6.85	7.06	7.39	7.33	7.30
4.00	6.78	6.98	7.27	7.23	7.19
5.00	6.69	6.85	7.10	7.09	7.04
6.00	6.87	7.06	7.36	7.31	7.27
7.00	6.76	6.95	7.24	7.20	7.16
8.00	6.64	6.79	7.13	7.05	7.03
9.00	6.78	6.98	7.27	7.23	7.19
10.00	6.75	6.95	7.13	7.11	7.06
Mean	6.76	6.95	7.24	7.20	7.16
CD at 5%	0.09				

On the basis of above result, it can be concluded that 4 percent gluten powder level was optimized for 15 percent barely flour incorporated bread. So it was selected for further investigation.

4.2. 5.3 Effect of surface active reagent (Sodium Steroly 2- Lactylate) on sensory characteristics of barley flour incorporated bread.

The effect of surface active regent (SSL) on sensory characteristics of 15 percent barely flour and 4 percent gluten powder included bread are given in Table- 4.20 to 4.25, respectively.

The results presented in Table- 4.20, showed that the maximum mean sensory score for crust colour (7.30) was observed with 1.5 percent surface active regent (SSL) incorporated bread. However, the variation in crust colour with other combinations was non significant.

From the results presented in Table 4.21, it can be revealed that the mean sensory scores for crumb colour was maximum (7.29) of bread made from 1.5 percent level of surface active reagent (SSL) and was significantly ($P \leq 0.05$) superior than control. On decreasing and increasing the level of surface active reagent (SSL), the variation in crumb colour was non significant.

The results presented in Table- 4.22, showed that the mean sensory scores for texture (7.60) was found maximum of the bread prepared with 1.5 percent level of surface active reagent (SSL). The variation in texture with 2.0 and 1.0 percent level of surface active reagent (SSL) was non significant.

Effect of Surface Active Reagent (SSL) on sensory characteristics of barley flour incorporated bread

Table no-4.20 **Crust Colour**

Panelists	Proportion of surface active reagent in 15 percent barley flour and 4 percent gluten powder incorporated optimized bread				
	0%	**0.5 %SAR**	**1.0%SAR**	**1.5%SAR**	**2.0%SAR**
1.00	7.15	7.21	7.24	7.28	7.23
2.00	7.27	7.30	7.31	7.33	7.35
3.00	7.31	7.37	7.42	7.43	7.42
4.00	7.24	7.28	7.30	7.33	7.31
5.00	7.13	7.14	7.13	7.19	7.16
6.00	7.32	7.37	7.39	7.42	7.40
7.00	7.21	7.25	7.27	7.30	7.28
8.00	7.09	7.08	7.16	7.15	7.15
9.00	7.24	7.28	7.30	7.33	7.31
10.00	7.15	7.23	7.18	7.25	7.21
Mean	7.21	7.25	7.27	7.30	7.28
CD at 5%	0.12				

Table no-4.21 **Crumb Colour**

Panelists	Proportion of surface active reagent in 15 percent barley flour and 4 percent gluten powder incorporated optimized bread				
	0%	**0.5%SAR**	**1.0%SAR**	**1.5%SAR**	**2.0%SAR**
1.00	7.09	7.16	7.21	7.27	7.21
2.00	7.21	7.25	7.28	7.32	7.33
3.00	7.25	7.31	7.39	7.42	7.40
4.00	7.18	7.23	7.27	7.32	7.29
5.00	7.07	7.09	7.10	7.18	7.14
6.00	7.26	7.31	7.36	7.41	7.38
7.00	7.15	7.20	7.24	7.29	7.26
8.00	7.03	7.03	7.13	7.14	7.13
9.00	7.18	7.23	7.27	7.32	7.29
10.00	7.09	7.18	7.15	7.24	7.19
Mean	7.15	7.20	7.24	7.29	7.26
CD at 5%	0.10				

Table no-4.22 **On Texture**

Panelists	Proportion of surface active reagent in 15 percent barley flour and 4 percent gluten powder incorporated optimized bread				
	0%	0.5 %SAR	1.0%SAR	1.5%SAR	2.0%SAR
1.00	7.33	7.39	7.44	7.53	7.49
2.00	7.45	7.51	7.56	7.67	7.61
3.00	7.51	7.57	7.62	7.72	7.67
4.00	7.42	7.48	7.53	7.63	7.58
5.00	7.28	7.34	7.39	7.49	7.44
6.00	7.51	7.57	7.62	7.72	7.67
7.00	7.39	7.45	7.50	7.60	7.55
8.00	7.24	7.29	7.34	7.44	7.39
9.00	7.42	7.48	7.53	7.63	7.58
10.00	7.36	7.42	7.47	7.57	7.52
Mean	7.39	7.45	7.50	7.60	7.55
CD at 5%	0.12				

Table no-4.23 **On Taste**

Panelists	Proportion of surface active reagent in 15 percent barley flour and 4 percent gluten powder incorporated optimized bread				
	0%	0.5%SAR	1.0%SAR	1.5%SAR	2.0%SAR
1.00	7.34	7.39	7.43	7.55	7.44
2.00	7.46	7.49	7.51	7.60	7.57
3.00	7.50	7.56	7.62	7.71	7.65
4.00	7.43	7.47	7.49	7.60	7.53
5.00	7.32	7.33	7.31	7.46	7.37
6.00	7.52	7.56	7.58	7.69	7.62
7.00	7.40	7.44	7.46	7.57	7.50
8.00	7.27	7.27	7.35	7.41	7.36
9.00	7.43	7.47	7.49	7.60	7.53
10.00	7.34	7.42	7.37	7.51	7.43
Mean	7.40	7.44	7.46	7.57	7.50
CD at 5%	0.12				

Table no-4.24 **On Flavour**

Panelists	Proportion of surface active reagent in 15 percent barley flour and 4 percent gluten powder incorporated optimized bread				
	0%	0.5 %SAR	1.0%SAR	1.5%SAR	2.0%SAR
1.00	7.13	7.21	7.29	7.43	7.32
2.00	7.25	7.30	7.36	7.48	7.44
3.00	7.29	7.37	7.47	7.59	7.51
4.00	7.22	7.28	7.35	7.48	7.40
5.00	7.11	7.14	7.18	7.34	7.24
6.00	7.30	7.37	7.44	7.57	7.49
7.00	7.19	7.25	7.32	7.45	7.37
8.00	7.07	7.08	7.21	7.29	7.23
9.00	7.22	7.28	7.35	7.48	7.40
10.00	7.13	7.23	7.23	7.40	7.30
Mean	7.19	7.25	7.32	7.45	7.37
CD at 5%	0.10				

Table no-4.25 **Over All Acceptability**

Panelists	Proportion of surface active reagent in 15 percent barley flour and 4 percent gluten powder incorporated optimized bread				
	0%	0.5%SAR	1.0%SAR	1.5%SAR	2.0%SAR
1.00	7.21	7.27	7.32	7.41	7.34
2.00	7.33	7.37	7.41	7.48	7.46
3.00	7.37	7.43	7.50	7.57	7.53
4.00	7.29	7.34	7.39	7.47	7.42
5.00	7.18	7.21	7.22	7.33	7.27
6.00	7.38	7.43	7.48	7.56	7.51
7.00	7.27	7.32	7.36	7.44	7.39
8.00	7.14	7.15	7.24	7.29	7.25
9.00	7.29	7.34	7.39	7.47	7.42
10.00	7.21	7.30	7.28	7.39	7.33
Mean	7.27	7.32	7.36	7.44	7.39
CD at 5%	0.10				

Effect of surface active reagent (SSL) on sensory characteristics of barley flour incorporated bread

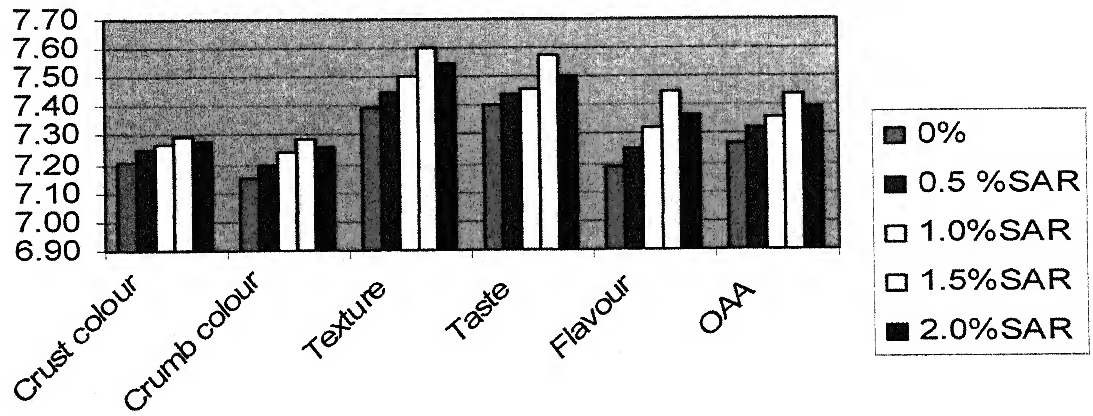


Fig no-4.3

The variation in texture of bread with control and 0.5 percent level of surface active reagent (SSL) was significant ($P<0.05$) with respect to 1.5 percent level of surface active reagent (SSL).

From the results shown in Table- 4.23, it can be revealed that the mean sensory score of taste was maximum (7.57) for bread made by adding 1.5 percent level of surface active reagent (SSL). The variation in taste of bread with 2.0 and 1.0 level of surface active reagent (SSL) was non significant and the varation with rest of the sample was significant ($P\leq 0.05$) in taste.

The results shown in Table- 4.24, indicated that the mean sensory score of flavour was maximum (7.45) for bread made by adding 1.5 percent surface active reagent (SSL). The variation in flavour with 2.0 percent level of surface active reagent (SSL) was non significant. However, the variation in flavour 1.5 percent (SSL) bread with control, 0.5 percent and 1.0 percent level of surface active reagent was significant ($P\leq 0.05$).

From the results presented in Table 4.25, it is revealed that the mean sensory score of over all acceptability was maximum (7.44) of bread prepared with 1.5 percent level of surface active reagent (SSL) and the variation with 1.0 and 2.0 percent inclusion of surface active reagent (SSL) was non significant. The variation in over all acceptability with control and 0.5 percent level of surface active reagent (SSL) was significant ($P\leq 0.05$).

On the basis of above results of sensory evaluation of various attributes 1.5 percent level of surface active reagent was optimum.

4.2.6 Effect of storage on moisture content of optimized bread (At refrigeration temperature and room temperature)

The result of the effect of storage at room temperature (35-37^0 C) & refrigeration temperature (4^0 C) on moisture content, of bread evaluated at an interval of 1 day for one weak are presented in Table- 4.26.

The result indicated a decrease in moisture content of bread on increasing the storage period at ambient temperature (35-37^0 C) and refrigeration temperature (4^0 C) at an interval of 1 day for one weak. However, the decrease in moisture at room temperature upto 3 days was non-significant and thereafter a significant ($P< 0.05$) variation was observed. The decrease in moisture content (at refrigeration temperature) upto 5 days was non-significant and thereafter a significant ($P<0.05$) variation was found. On storage there was a decrease in moisture content and increase in compression force of the bread which showed an increase in hardness of bread.

Savita Sharma et al (1999) also reported similar results and showed a decrease in moisture and increase in instron force indicating decreased softness of the product on storage at 37^{0}C and 4^{0}C.

Table no- 4. 26 Effect of storage on moisture content of barley flour incorporated bread (At refrigeration temperature and room temperature)

Storage Period (No of days)	Moisture Content	
	Refrigeration Temperature (4°C)	Room Temperature (35-37 °C)
0	37.62	37.62
1	37.29	36.92
2	36.92	36.2
3	36.51	35.5
4	35.99	34.78
5	35.41	34.05
6	34.94	33.35
7	34.62	32.85
Mean	36.16	35.158
CD at 5 % level	2.22	2.14

Table no- 4. 27 Effect of storage on textural profile of barley incorporated bread (At refrigeration temperature and room temperature)

Storage Period (No of days)	Force in kg	
	Refrigeration Temperature (4°C)	Room Temperature (35-37 °C)
0	2.196	2.196
1	2.615	2.724
2	3.037	3.098
3	3.455	3.557
4	3.973	4.016
5	4.492	5.092
6	5.016	6.123
7	6.211	7.184
Mean	3.874	4.248
CD at 5 % level	2.30	1.376

4.2.7 Effect of storage period on texture profile analysis of barley flour optimized bread (At refrigeration temperature and room temperature)

The results of the effect of storage time and temperature on textural profile force (in kg) of 15 percent barley flour, 4 percent gluten and 1.5 percent surface active reagent (SSL) incorporated bread are resented in Table- 4.27. The observations were made at an interval of 1 day for 7 days at both the temperature i.e. refrigerator temperature (4^0 C) and room temperature (35-37^0 C).

The results revealed an increase in compression peak force (in kg) of bread with an increase of storage time at both the temperatures. The minimum and maximum compression forces were 2.196 and 6.211 kg, respectively at refrigeration temperature and 2.196 kg and 7.184 kg, respectively at room temperature. The variation in compression force was non-significant upto 3 days of storage at room temperature and 5 days of storage at refrigeration temperature. Thereafter a significant ($P \leq 0.05$) variation was observed at both the temperature. On storage there was a decrease in moisture content and increase in compression force of the bread which indicated the increase in hardness of bread

The results indicated that the hardness is increasing on increasing the storage time at both the temperatures. The increase in hardness may be because of removal of moisture during storage and its effect on starch. The increase in hardness of bread stored at room temperature was more as compared to refrigeration temperature. As a result of which, more compression force was required at room temperature as compared to refrigeration temperature.

4.2.8 Effect of storage period on organoleptic characteristics of barley flour optimized bread at storage condition

a) At ambient temperature (35-37^0 C)

The results of the effect of storage time at room temperature (35-37^0 C) on sensory parameters like (crust colour, crumb colour, taste, flavour and over all acceptability) were evaluated at an interval of 1 day for one week of barley incorporated bread is presented in table 4.28 to 4.32.

The mean sensory score for crust colour of barley flour bread are presented in Table 4.28. The results indicated that the variation in crust colour scores was non-significant up to 3 days. Thereafter that a significant ($P\leq 0.05$) variation was observed. The mean sensory score for crust colour was in acceptable range up to 7 days of storage.

The results presented in Table- 4.29, indicated a decrease in crumb colour of bread on increasing the storage periods. However, the decrease in crumb colour up to 3 day was non-significant thereafter a significant ($P\leq 0.05$) decrease in crumb colour was noted. The crumb colour was in acceptable range upto 7 days of storage period.

The results presented in Table -4.30, showed a decrease in mean sensory score for taste of bread with increase in storage periods at ambient temperature (35-37^0 C). The decrease upto 3 days was non-significant thereafter a significant ($P\leq 0.05$) decrease was observed. However, the taste was in acceptable range upto 7 days of storage.

Table no- 4.28 Sensory score of crust colour of barley flour optimized bread at ambient temperature (35-37^{0}C)

Panelists	Storage periods (days)							
	0	1	2	3	4	5	6	7
1	8.11	8.08	8.08	8.05	7.84	7.57	7.29	5.96
2	8.25	8.19	8.16	8.10	7.98	7.70	7.41	6.06
3	8.29	8.26	8.28	8.22	8.05	7.78	7.48	6.12
4	8.21	8.16	8.14	8.10	7.93	7.66	7.37	6.02
5	8.09	8.01	7.95	7.95	7.76	7.50	7.21	5.90
6	8.31	8.26	8.24	8.20	8.03	7.75	7.46	6.10
7	8.18	8.13	8.11	8.07	7.90	7.63	7.34	6.00
8	8.04	7.94	7.99	7.90	7.75	7.49	7.21	5.89
9	8.21	8.16	8.14	8.10	7.93	7.66	7.37	6.02
10	8.11	8.11	8.01	8.01	7.82	7.56	7.27	5.94
Mean	8.18	8.13	8.11	8.07	7.9	7.63	7.34	6
CD at 5%	0.12							

Table no- 4.29 Sensory score of crumb colour of barley flour optimized bread at ambient temperature (35-37^{0}C)

Panelists	Storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.75	7.77	7.74	7.67	7.55	7.44	7.38	7.06
2	7.89	7.88	7.82	7.72	7.68	7.57	7.50	7.18
3	7.93	7.94	7.93	7.83	7.76	7.65	7.58	7.25
4	7.85	7.85	7.80	7.72	7.64	7.53	7.46	7.14
5	7.73	7.71	7.62	7.58	7.48	7.37	7.30	6.99
6	7.94	7.94	7.89	7.81	7.73	7.62	7.55	7.22
7	7.82	7.82	7.77	7.69	7.61	7.50	7.43	7.11
8	7.69	7.64	7.66	7.53	7.47	7.36	7.29	6.98
9	7.85	7.85	7.80	7.72	7.64	7.53	7.46	7.14
10	7.75	7.80	7.67	7.63	7.54	7.43	7.36	7.04
Mean	7.82	7.82	7.77	7.69	7.61	7.5	7.43	7.11
CD at 5%	0.13							

Table no- 4.30 Sensory score of taste of barley flour optimized bread at ambient temperature (35-37^{0}C)

Panelists	Storage periods (days)							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	8.04	8.05	8.00	7.97	7.80	7.69	7.56	6.75
2	8.18	8.16	8.08	8.02	7.94	7.83	7.69	6.87
3	8.22	8.23	8.20	8.14	8.01	7.90	7.77	6.93
4	8.14	8.13	8.06	8.02	7.89	7.78	7.65	6.82
5	8.02	7.98	7.87	7.87	7.73	7.62	7.49	6.68
6	8.24	8.23	8.16	8.12	7.99	7.87	7.74	6.91
7	8.11	8.10	8.03	7.99	7.86	7.75	7.62	6.80
8	7.97	7.91	7.91	7.82	7.72	7.61	7.48	6.68
9	8.14	8.13	8.06	8.02	7.89	7.78	7.65	6.82
10	8.04	8.08	7.93	7.93	7.78	7.67	7.55	6.73
Mean	8.11	8.1	8.03	7.99	7.86	7.75	7.62	6.8
CD at 5%	0.12							

Table no- 4.31 Sensory score of flavour of barley flour optimized bread at ambient temperature (35-37^{0}C)

Panelists	Storage periods (days)							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	7.87	7.83	7.81	7.76	7.68	7.54	7.44	7.15
2	8.01	7.94	7.89	7.81	7.82	7.67	7.57	7.27
3	8.05	8.01	8.00	7.92	7.89	7.75	7.65	7.34
4	7.97	7.91	7.87	7.81	7.77	7.63	7.53	7.23
5	7.85	7.76	7.69	7.67	7.61	7.47	7.37	7.08
6	8.07	8.01	7.96	7.90	7.86	7.72	7.62	7.31
7	7.94	7.88	7.84	7.78	7.74	7.60	7.50	7.20
8	7.80	7.70	7.72	7.62	7.60	7.46	7.36	7.07
9	7.97	7.91	7.87	7.81	7.77	7.63	7.53	7.23
10	7.87	7.86	7.74	7.72	7.66	7.53	7.43	7.13
Mean	7.94	7.88	7.84	7.78	7.74	7.6	7.5	7.2
CD at 5%	0.17							

Table no – 4.32 Sensory score of over all acceptability of barley flour optimized bread at ambient temperature (35-37^{0}C)

Panelists	Storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.94	7.91	7.87	7.85	7.76	7.57	7.37	7.11
2	8.08	8.02	7.95	7.90	7.90	7.70	7.49	7.23
3	8.12	8.09	8.06	8.01	7.97	7.78	7.57	7.30
4	8.04	7.99	7.93	7.90	7.85	7.66	7.45	7.19
5	7.92	7.84	7.75	7.75	7.69	7.50	7.29	7.04
6	8.14	8.09	8.03	8.00	7.94	7.75	7.54	7.27
7	8.01	7.96	7.90	7.87	7.82	7.63	7.42	7.16
8	7.87	7.77	7.78	7.71	7.68	7.49	7.28	7.03
9	8.04	7.99	7.93	7.90	7.85	7.66	7.45	7.19
10	7.94	7.94	7.80	7.81	7.74	7.56	7.35	7.09
Mean	8.01	7.96	7.9	7.87	7.82	7.63	7.42	7.16
CD at 5%	0.14							

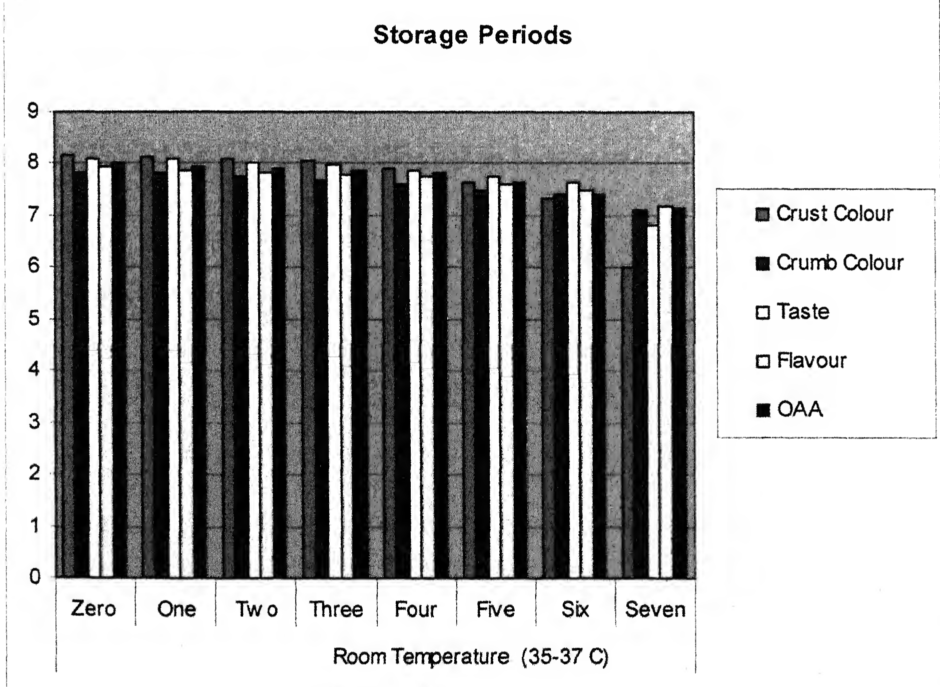


Fig no-4.4

The results presented in Table- 4.31, indicated a decrease in flavour of bread with an increase in storage period. The decrease in the mean flavour scores upto 3 days was non-significant. Thereafter a significant ($P \leq 0.05$) decrease in flavour was observed. However the bread was in acceptable range for 7 days of storage with respect to flavours.

The mean sensory score for overall acceptability of barley flour incorporated bread are presented in Table- 4.32. The over all acceptability of bread showed a decreasing trend on increasing the storage period and the variation was non-significant upto 3 day thereafter a significant ($P \leq 0.05$) variation was observed. However, the mean sensory score for over all acceptability was in acceptable range upto 7 days of storage.

On the basis of above results, it was observed that the barley flour incorporated bread could be stored upto 3 days at room temperature. **Sharma et al (1999)** also reported similar decrease in organoleptical parameters when stored at 37^0 C temperature.

b) At refrigeration temperature

The results of the effect of storage time at refrigeration temperature (4^0 C) on sensory parameters such as crust colour, crumb colour, taste, flavour and over all acceptability were evaluated at an interval of 1 day for one week of barley included bread are presented in Table- 4.33-4.37.

The results presented in Table-4.33, indicated a decreasing trend in the mean sensory score for crust colour of bread. The variation in mean sensory score of crust colour of bread was non-significant upto 5 days of storage. Thereafter a significant ($P \leq 0.05$) variation was observed. However the mean sensory scores for crust colour was in acceptable range upto 7 days of storage.

Table no-4.33 Sensory score of crust colour of barley flour optimized bread at refrigerated temperature (4^0C)

Panelists	Storage periods (days)							
	0	1	2	3	4	5	6	7
1	8.13	8.12	8.09	8.08	8.04	8.01	7.55	7.05
2	8.27	8.23	8.17	8.13	8.18	8.15	7.68	7.17
3	8.31	8.30	8.29	8.25	8.26	8.23	7.76	7.24
4	8.23	8.20	8.15	8.13	8.13	8.10	7.64	7.13
5	8.11	8.05	7.96	7.98	7.96	7.93	7.48	6.98
6	8.33	8.30	8.25	8.23	8.23	8.20	7.73	7.21
7	8.20	8.17	8.12	8.10	8.10	8.07	7.61	7.10
8	8.06	7.98	8.00	7.93	7.95	7.92	7.47	6.97
9	8.23	8.20	8.15	8.13	8.13	8.10	7.64	7.13
10	8.13	8.15	8.02	8.04	8.02	7.99	7.54	7.03
Mean	8.2	8.17	8.12	8.1	8.1	8.07	7.61	7.1
CD at 5%	0.13							

Table no- 4.34 Sensory score of crumb colour of barley flour optimized bread at refrigerated temperature (4^0C)

Panelists	Storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.78	7.78	7.75	7.73	7.66	7.63	7.14	6.95
2	7.92	7.89	7.83	7.78	7.80	7.77	7.26	7.07
3	7.96	7.95	7.94	7.89	7.87	7.84	7.33	7.14
4	7.88	7.86	7.81	7.78	7.75	7.72	7.22	7.03
5	7.76	7.71	7.63	7.64	7.59	7.56	7.07	6.88
6	7.97	7.95	7.90	7.87	7.84	7.81	7.30	7.11
7	7.85	7.83	7.78	7.75	7.72	7.69	7.19	7.00
8	7.72	7.65	7.67	7.59	7.58	7.55	7.06	6.87
9	7.88	7.86	7.81	7.78	7.75	7.72	7.22	7.03
10	7.78	7.81	7.68	7.69	7.64	7.61	7.12	6.93
Mean	7.85	7.83	7.78	7.75	7.72	7.69	7.19	7
CD at 5%	0.16							

Table no-4. 35 Sensory score of taste of barley flour optimized bread at refrigerated temperature (4°C)

Panelists	Storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.96	7.96	7.97	7.94	7.84	7.82	7.54	7.15
2	8.10	8.07	8.05	7.99	7.98	7.96	7.67	7.27
3	8.14	8.14	8.17	8.11	8.05	8.03	7.75	7.34
4	8.06	8.04	8.03	7.99	7.93	7.91	7.63	7.23
5	7.94	7.89	7.84	7.84	7.76	7.74	7.47	7.08
6	8.16	8.14	8.13	8.09	8.03	8.01	7.72	7.31
7	8.03	8.01	8.00	7.96	7.90	7.88	7.60	7.20
8	7.89	7.82	7.88	7.79	7.75	7.74	7.46	7.07
9	8.06	8.04	8.03	7.99	7.93	7.91	7.63	7.23
10	7.96	7.99	7.90	7.90	7.82	7.80	7.53	7.13
Mean	8.03	8.01	8	7.96	7.9	7.88	7.6	7.2
CD at 5%	0.15							

Table no-4.36 Sensory score of flavour of barley flour optimized bread at refrigerated temperature (4°C)

Panelists	Storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.83	7.85	7.83	7.82	7.75	7.68	7.64	7.35
2	7.97	7.96	7.91	7.87	7.89	7.82	7.78	7.47
3	8.01	8.03	8.02	7.98	7.96	7.89	7.85	7.54
4	7.93	7.93	7.89	7.87	7.84	7.77	7.73	7.43
5	7.81	7.78	7.71	7.72	7.68	7.61	7.57	7.27
6	8.03	8.03	7.99	7.96	7.93	7.86	7.82	7.52
7	7.90	7.90	7.86	7.84	7.81	7.74	7.70	7.40
8	7.76	7.72	7.74	7.68	7.67	7.60	7.56	7.26
9	7.93	7.93	7.89	7.87	7.84	7.77	7.73	7.43
10	7.83	7.88	7.76	7.78	7.73	7.66	7.62	7.33
Mean	7.9	7.9	7.86	7.84	7.81	7.74	7.7	7.4
CD at 5%	0.16							

Table no-4. 37 Sensory score of over all acceptability of barley flour optimized bread at refrigerated temperature (4°C)

Panelists	Storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.89	7.85	7.85	7.86	7.80	7.76	7.70	7.41
2	8.03	7.96	7.93	7.91	7.94	7.90	7.84	7.53
3	8.07	8.03	8.04	8.02	8.01	7.97	7.91	7.61
4	7.99	7.93	7.91	7.91	7.89	7.85	7.79	7.49
5	7.87	7.78	7.73	7.76	7.73	7.69	7.63	7.33
6	8.09	8.03	8.01	8.01	7.99	7.94	7.88	7.58
7	7.96	7.90	7.88	7.88	7.86	7.82	7.76	7.46
8	7.82	7.72	7.76	7.72	7.72	7.68	7.62	7.32
9	7.99	7.93	7.91	7.91	7.89	7.85	7.79	7.49
10	7.89	7.88	7.78	7.82	7.78	7.74	7.68	7.39
Mean	7.96	7.9	7.88	7.88	7.86	7.82	7.76	7.46
CD at 5%	0.14							

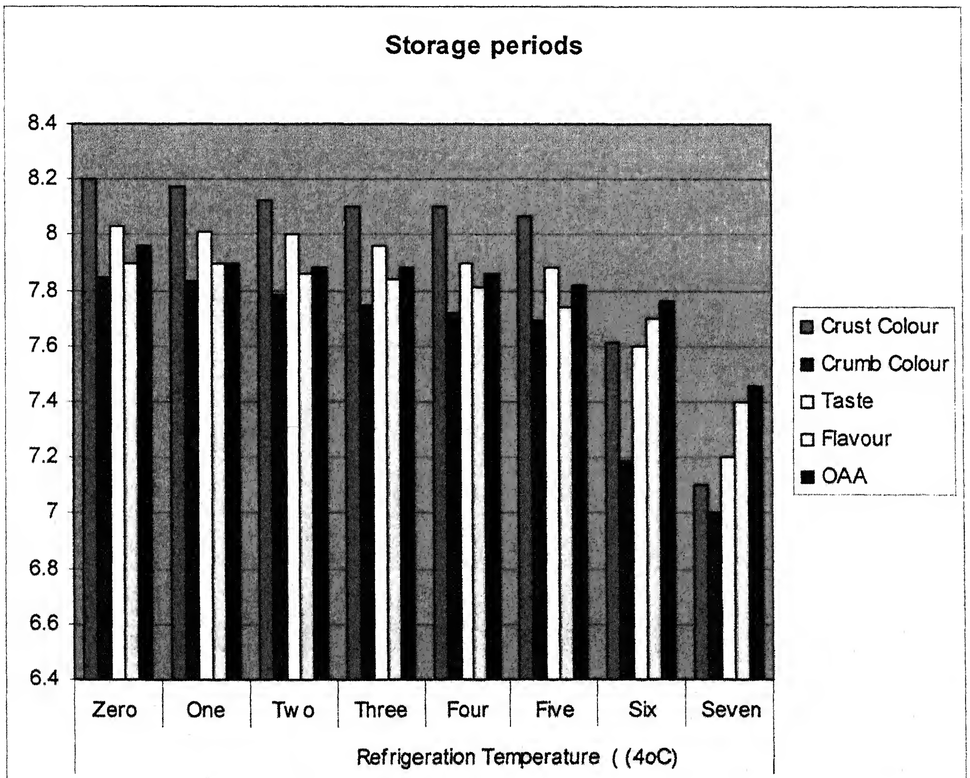


Fig no-4.5

The results presented in Table- 4.34, indicated a decrease in crumb colour of bread on increasing the storage periods. The decrease in crumb colour upto 5 days was non-significant and thereafter a significant ($P \leq 0.05$) decrease in crumb colour was observed. The crumb colour was in acceptable range upto 7 days of storage periods.

The results presented in Table -4.35, showed a decrease in mean sensory score for taste of bread on increasing the storage periods at refrigerated temperature. The decrease upto 5 days was non-significant, thereafter a significant ($P \leq 0.05$) decrease was observed. The taste was in acceptable range upto 7 days of storage.

The results presented in Table-4.36, indicated a decrease in flavour of bread with an increase in storage period. The sample were analysed at an interval of 1 day for one week. The decrease in the mean flavour scores upto 5 days was non-significant thereafter a significant ($P \leq 0.05$) decrease in flavour was observed. However, the bread was in acceptable range for 7 days of storage with respect to flavour.

From the results presented in Table- 4.37, it is depicted that a decrease in over all acceptability was observed with increase in storage time and the variation in over all acceptability upto 5 days was non-significant thereafter a significant ($P \leq 0.05$) decrease in over all acceptability was observed. **Sharma et al., (1999)** also reported similar decreasing trend for organoleptically acceptability with increase in storage period at refrigeration temperature.

4.3 EFFECT OF BLENDING OF DEFATTED SOY FLOUR, GLUTEN POWDER AND SURFACE ACTIVE REAGENT (Sodium Sterol-2- Lacterol) ON FUNCTIONAL, PHYSICAL, CHEMICAL AND SENSORY CHARACTERISTICS OF BLENDS AND THEIR BREADS

4.3.1 Effect of Blending on Functional Characteristics of Flour and Blends

The physical characteristics such as sedimentation value, polenshke value, water absorption, wet gluten, dry gluten and wet/ dry ratio of white flour, defatted soy flour and blends of these are presented in Table- 4.38.

The results revealed that white flour (30.25ml) had a higher sedimentation value than soy flour (25.10 ml). The incorporation of defatted soy flour in white flour at 5, 10, 15 and 20 percent level produced a gradual decrease in sedimentation value of blends and the decrease in sedimentation value was significant ($P \leq 0.05$). **Dhingra and Jood (2004)** reported similar decrease in sedimentation value with incorporation of defatted soy flour in white flour.

The polenshke value for white flour and defatted soy flour were 126.0 and 101.0 minutes, respectively. There was a gradual decrease in polenshke value with incorporation of defatted soy flour (5 to 20 percent) in white flour from 120 minutes to 102 minutes and the decrease in polenshke value was significant ($P \leq 0.05$). The polenshke value of white flour might be higher than the defatted soy flour as it has higher amount of gluten.

Table no- 4.38 Effect of blending on functional characteristics of flour and blends

Constituents	Sedimentation value (ml)	Polenshke value (mini)	Water absorption (%)	Wet gluten (%)	Dry gluten (%)	Wet /Dry ratio
WF: DSF						
100:00	30.25	126.0	60.20	30.20	9.36	3.226
95:5	29.45	120.0	61.05	28.96	8.98	3.225
90:10	28.24	113.0	62.47	27.14	8.42	3.224
85:15	27.18	107.0	63.02	25.62	7.95	3.223
80:20	26.09	102.0	64.0	24.13	7.49	3.222
00:100	25.10	101.0	64.19	-	-	-
Mean	27.71	111.5	62.48	27.21	8.42	3.224
CD ($P\leq 0.05$)	0.75	2.82	0.33	1.02	0.37	0.015

Values are average of three determinations

The value of water absorption for white flour and defatted soy flour were 60.20 and 64.19 percent, respectively. The water absorption values increased from 61.05 to 64.19 percent in blends with incorporation of defatted soy flour in white flour from 5 to 20 percent level and the increase was significant ($P \leq 0.05$). The water absorption value of defatted soy flour might be higher than white flour because of the higher amount of crude fibre and protein in soy flour. **Galan et al. (1991)** reported the water absorption (57.6 percent)in white flour and increase in water absorption value with incorporation of defatted soy flour and rice flour. The variation in water absorption value in white flour might be due to the difference in refining. **Dhingra and Jood (2004)** reported similar trend of increase in water absorption (72.25 to 81.68 percent) with increase in the level of defatted soy flour from 5 to 20 percent.

The wet and dry gluten content of the white flour were 30.20 and 9.36 percent, respectively. The result of wet gluten content (30.20 percent) of the present investigation were in the range of 27.07 to 30.40 percent reported by **Patel and Rao(1995) and Bala et al (2004)**. However, the values of dry gluten content (9.36 percent) of present investigation were lower than the range (10.13 to 11.12 percent) reported by **Patel and Rao(1995) and Bala et al (2004)** and were in close conformity with results (6.4 to 9.5 percent) reported by **Gupta and Pingale (1970).**

The result presented in Table- 4.38, revealed that the incorporation of soy flour in white flour from 0 to 20 percent decreased proportionately the wet gluten 30.20 to 24.13 percent in blends and the decrease was significant ($P \leq 0.05$). **Dhingra and Jood (2004)**

reported similar trend of decrease in wet gluten percent by inclusion of defatted soy flour (5 to 20 percent) in white flour.

The result of present investigation indicated in Table- 4.38, showed that the incorporation of soy flour in white flour from 0 to 20 percent decreased the dry gluten proportionately from 9.36 to 7.49 percent in blends and the decrease was significant ($P \leq 0.05$). **Dhingra and Jood (2004)** reported similar trend of decrease in dry gluten percent by inclusion of defatted soy flour (5 to 20 percent) in white flour and value ranges from 9.46 to 7.68 percent.

The value of wet/ dry ratio of white flour was 3.226.The wet/ dry ratio value decreased from 3.226 to 3.222 in blends with incorporation of defatted soy flour in white flour from 0 to 20 percent and the decrease in wet /dry ratio was nonsignificant.

4.3.2 Effect of blending on chemical composition of white flour and defatted soy flour blends

The results of the effect of blending of defatted soy flour (5 to 20 percent) on chemical composition such as protein, fat, ash, crude fibre, carbohydrate, calcium, phosphorus and iron content of blends are presented in Table- 4.39.

The protein content of white flour and defatted soy flour were 10.14 and 45.1 percent, respectively. The protein content increased proportionately from 11.89 to 18.65 percent on incorporation of defatted soy flour in white flour from 5 to 20 percent and the increase in protein content was significant ($P \leq 0.05$). The increase in protein content in

blends attributed to the higher value of protein content in defatted soy flour. This indicated that blends of white flour with defatted soy flour would contain higher amount of protein with improved nutritional values as soy protein contains essential amino acid. A similar trend of increase in protein content in flour blends with incorporation of barley flour, full fat soy flour, and defatted soy flour in wheat flour was observed by **Dhingra and Jood (2004)**.

The fat content for white flour and defatted soy flour were 0.68 and 0.87 percent. There was a gradual increase in fat content with incorporation of defatted soy flour (5-20 percent) in white flour from 0.69 to 0.81 percent. The increase in fat content up to 10 percent incorporation of defatted soy flour was non significant thereafter a significant ($P \leq 0.05$) increase was observed. **Diwan et al. (1982) and Hooda and Jood, (2004)** also reported an increase in fat content of blends with incorporation of mung flour, fenugreek flour and defatted soy flour in wheat flour.

The values of ash content in white flour and defatted soy flour were 0.58 and 5.12 percent, respectively. The incorporation of defatted soy flour (5 to 20 percent) in white flour produced increase in ash content of blends from 0.80 to 1.55 percent and the increase upto 10 percent was non significant thereafter a significant ($P \leq 0.05$) variation was found. The increase in ash content was attributed to higher ash content in defatted soy flour. **Diwan et al (1982) ,Patel and Rao, (1995) and Jood (2004)** observed an increase in ash content of blends with incorporation of mung flour , black gram flour and defatted soy flour in wheat flour.

Table no- 4.39 Effect of blending on chemical composition of white flour and defatted soy flour blends

WF: DSF	Protein	Fat	Ash	Crude fibre	Carbohydrate	Calcium	Phosphorus	Iron
100:00	10.14	0.68	0.58	0.29	88.31	30.10	138.01	2.48
95:5	11.89	0.69	0.80	0.46	86.16	41.15	155.75	2.87
90:10	14.15	0.73	1.05	0.65	83.42	53.50	180.24	3.38
85:15	16.39	0.77	1.31	0.84	80.69	65.25	204.90	3.90
80:20	18.65	0.81	1.55	1.03	77.96	77.80	228.90	4.42
00:100	45.1	0.87	5.12	3.80	45.1	251.4	493.10	10.30
Mean	19.38	0.758	1.735	1.178	76.94	86.53	233.48	4.550
CD($P \leq 0.05$)	0.92	0.06	0.52	0.39	0.85	1.42	3.225	0.303

Values are average of three determinations

The results presented in Table- 4.39, revealed an increase in crude fibre content of flour blends. The crude fibre content was observed lowest (0.29 percent) in control and highest (3.80 percent) in soy flour. There was a gradual increase in crude fibre (0.46 to 1.03 percent) with incorporation of defatted soy flour (5 to 20 percent) in white flour. The increase in crude fibre upto 10 percent was non significant thereafter a significant ($P \leq 0.05$) increase was noted. The increase in values of crude fibre in blends was due to higher amount of crude fibre in defatted soy flour. **Hooda and Jood, (2004)** also reported an increase in total dietary fibre in wheat and fenugreek composite flour and soy composite flour.

The carbohydrate content in white flour and defatted soy flour were 88.31 and 45.1 percent, respectively. The blending of defatted soy flour with white flour decreased the carbohydrate from 86.16 to 77.96 percent with increase in defatted soy flour from 5 to 20 percent, respectively and the decrease in carbohydrate content was significant ($P \leq 0.05$). The decrease in carbohydrate content in blends might be due to lower carbohydrate in defatted soy flour.

The calcium content in white flour and defatted soy flour were 30.10 and 251.4 mg/100g, respectively. The result revealed gradual increase (41.15 to 77.80 mg/100g) in calcium content with blending of defatted soy flour (5 to 20 percent) in white flour and the variation in calcium content was significant ($P \leq 0.05$). The increase in the values of calcium content was attributed to the higher content of calcium in defatted soy flour. **Hooda and Jood, (2004)** also reported an increase in calcium content in wheat and fenugreek composite flour.

The results presented in Table- 4.39, showed an increase in phosphorus content of composite flours made up of white flour and defatted soy flour. The values of phosphorus content in white flour and defatted soy flour were 138.0 and 493.10 mg/100g. The phosphorus content increased from 155.75 to 228.90 mg/100g in blends with incorporation of defatted soy flour from 5 to 20 percent and the increase was significant ($P \leq 0.05$).

The results indicated in Table- 4.39, revealed an increase in iron content of blends with an increase in the level of defatted soy flour from 5 to 20 percent in white flour and the variation was significant ($P \leq 0.05$). Iron content was minimum (2.48 mg/100g) in white flour and maximum (10.30 mg/100g) in defatted soy flour. The increase in iron content of blends was due to higher content of iron in defatted soy flour. **Hooda and Jood, (2004)** also reported an increase in iron content in wheat and fenugreek composite flour.

4.3.3 Physical characteristics of bread (baking characteristic)

4.3.3.1 Effect of incorporation of defatted soy flour levels on physical characteristics of bread

The results of the effect of defatted soy flour incorporation on physical characteristics such as loaf weight, loaf volume, specific loaf volume, slice height, loaf height and compression force (TPA) of bread are presented in Table-4.40. The results revealed a gradual increase in weight of defatted soy flour incorporated bread with increase in the level of defatted soy flour from 0 to 20 percent in white flour and the increase in weight of bread was significant ($P \leq 0.05$). The results of present investigation were comparable with those reported by earlier authors for incorporation of defatted soy

flour from 5 to 20 percent and are in close conformity to the results reported by **Jood et al.,(2004)**.

The results presented in Table-4.40, showed a significant ($P \leq 0.05$) reduction in loaf volume of bread with incorporation of defatted soy flour level from 0 to 20 percent in white flour. The highest reduction in loaf volume was noted in bread made from 20 percent defatted soy flour blends. It could be because of the dilution of gluten on addition of defatted soy flour and hence less retention of CO_2 gas caused the depression of loaf volume **(Ereifej & Shibli (1993) and Sharma and Chauhan., 2000**). Almost similar results for loaf volume were reported by **Dhingra** and **Jood (2004)**

The value of specific loaf volume was highest (3.21 mlg^{-1}) for control sample and lowest (2.775 mlg^{-1}) for 20 percent soy fortified bread. There was a significant ($P \leq 0.05$) decrease in the specific loaf volume with increase in the level of defatted soy flour in white flour. The poor quality and quantity of gluten in defatted soy flour blended breads may be responsible for less retention of CO_2 gas in the fermented dough and low specific loaf volume. **Dhingra and Jood (2004)** reported similar decrease in specific loaf volume with incorporation of defatted soy flour (5 to 20 percent) in white flour.

The results presented in Table- 4.40, revealed a gradual decrease in slice height with increase in level of defatted soy flour in breads. The value for slice height was maximum (6.93 cm) for control bread and minimum (5.89 cm) for 20 percent defatted soy flour incorporated bread.

Table no- 4.40 Effect of incorporation of defatted soy flour on the physical characteristics of bread

Proportion of defatted soy flour (%)	Loaf weight (gm)	Loaf volume (ml)	Specific loaf volume (mlg-1)	Slice height (cm)	Loaf height	Compression force in kg (TPA)
0	160.20	515.0	3.214	6.93	7.23	2.455
5	163.50	504.50	3.091	6.70	6.93	2.703
10	166.12	492.73	2.966	6.41	6.62	2.911
15	169.32	480.0	2.834	6.15	6.29	3.936
20	171.50	476.0	2.775	5.89	6.03	4.887
Mean	166.128	493.64	2.976	6.416	6.62	3.378
CD ($P \leq 0.05$)	1.54	2.62	0.120	0.15	0.250	0.220

Values are average of three determinations

The decrease in slice height of blended bread with increase the level of defatted soy flour in white flour was significant ($P \leq 0.05$). The decrease in slice height might be because of decrease in gluten percentage with addition of defatted soy flour as a result of which less retention of CO_2 gas and lower increase in volume.

The results presented in Table- 4.40, showed a gradual decrease in loaf height of bread with incorporation of defatted soy flour in white flour. The loaf height of bread decreased from 7.23 cm (control) to 6.03 cm in (20 percent defatted soy flour) incorporated bread. There was a significant ($P \leq 0.05$) decrease in loaf height of bread with increase in level of defatted soy flour. The reduction in loaf height of bread was due to the decrease in loaf volume of bread brought by reduced gluten content in blends and hence less retention of CO_2 gas.

The results presented in Table- 4.40, indicated an increase in the value of compression force (in kg) with increase in defatted soy flour level in bread. The values for compression force were in the range of 2.455 kg to 4.887 kg. The maximum value of compression force was observed for 20 percent level of defatted soy flour bread while the minimum value was reported for the control bread. The statistical analysis revealed a significant ($P \leq 0.05$) increase in compression force of bread with increase in defatted soy flour level.

4.3.3.2 Effect of gluten powder level on physical characteristics of defatted soy flour incorporated bread

The results showing the effect of inclusion of gluten powder on the loaf weight, loaf volume, specific loaf volume, slice height, loaf height and compression force of

defatted soy flour incorporated bread are presented in Table- 4.41. The results revealed a gradual increase in loaf weight of bread from 166.12 to 167.45 (gm) with increase in gluten powder level from 0 to 8 percent. The loaf weight of defatted soy flour incorporated bread increased proportionately and the variation was significant ($P \leq 0.05$). The increase in loaf weight might be due to more absorption of water because of increase in the level of gluten.

The loaf volume of bread increased from 492.93 to 513.20 ml with increase in gluten from 0 to 8 percent, respectively. The increase in loaf volume was significant ($P \leq 0.05$) up to 2 percent inclusion of gluten powder however the increase with 4 percent gluten and above was significant ($P \leq 0.05$). **Kaur et al.,(2006) also** reported an increase in loaf volume of bread with 10 percent increase of Indian gluten content. The increase in loaf volume may be due to the increase in puffiness of loaf because of more production and retention of gases liberated during fermentation and baking.

The results revealed a proportionate increase in specific loaf volume of defatted soy flour incorporated bread ranged from 2.96 to 3.064 mlg^{-1} on increasing gluten powder from 0 to 8 percent and the increase in specific loaf volume was significant ($P \leq 0.05$) with 6 and 8 percent inclusion of gluten powder while the increase with 2 and 4 percent gluten powder was non significant in comparison to control. **Kaur et al.,(2006)** reported an increase in specific loaf volume of bread with10 percent of inclusion of Indian gluten .

Table no- 4.41 Effect of gluten powder level on physical characteristics of defatted soy flour fortified bread

Proportion of GP (%)	Loaf weight (gm)	Loaf volume (ml)	Specific loaf volume (mlg-1)	Slice height (cm)	Loaf height	Compression force in kg (TPA)
0	166.12	492.93	2.96	6.41	6.62	2.911
2	166.67	495.91	2.98	6.62	6.82	2.623
4	166.92	503.67	3.017	6.83	7.01	2.306
6	167.17	508.62	3.042	6.98	7.17	1.981
8	167.45	513.20	3.064	7.06	7.29	1.542
Mean	166.86	503.26	3.0126	6.78	6.982	2.272
CD ($P \leq 0.05$)	0.210	1.24	0.06	0.12	0.10	0.189

Values are average of three determinations

The results revealed an increase in the slice height with increasing level of gluten powder. The value of slice height increased from 6.41 to 7.06 cm with increase in gluten powder level from 0 to 8 percent. The increase in slice height of bread was found significant ($P \leq 0.05$) with increase in gluten powder level in bread. **Kaur et al.,(2006)** reported an increase in slice height of bread with10 percent inclusion of Indian gluten.

From the Table- 4.41, it was observed that the inclusion of gluten powder (2 to 8 percent) showed a proportionate increase in loaf height. The results showed that the loaf height was lowest (6.62 cm) for control sample and highest (7.29 cm) with 8 percent gluten powder. The increase in loaf height was significant ($P \leq 0.05$) with increase in gluten powder level. **Kaur et al.,(2006)** reported an increase in loaf height of bread with 10 percent inclusion of Indian gluten content.

The result of effect of gluten incorporated on texture of defatted soy flour included bread shown in Table-4.41, revealed a proportionate decrease in hardness and the decrease was significant ($P \leq 0.05$) with gluten powder level. The compression force was maximum (2.911 kg) in control sample and the compression force decreased from 2.911 to 1.542 kg with increase in gluten powder level from 0 to 8 percent, respectively.

The increase in loaf weight, loaf volume, specific loaf volume, slice height, loaf height and decrease in hardness might be due to the increase in puffiness of loaf because of more production and retention of gases liberated during fermentation and baking with enhanced level of gluten in defatted soy flour included bread.

4.3.3.3 Effect of surface active reagent (Sodium Stearoly-2- Lactylate) level on physical characteristics of defatted soy flour fortified bread

The results showing the effect of surface active reagent on physical characteristics of defatted soy flour incorporated bread are presented in Table -4.42. From the results it is revealed that the loaf weight showed an increase on increasing the level of flour improver (surface active reagent) from 0.5 to 2.0 percent and the variation was significant ($P \leq 0.05$). The increase in loaf weight with 10 percent incorporation of Indian gluten powder and 0.5 percent surface active reagent (SSL) in bread was reported by **Kaur et al., (2006)**. The increase in loaf weight might be due to increase in absorption of water because of addition of flour improver.

The result presented in Table-4.42, revealed an increase in loaf volume on increasing surface active reagent level (SSL) from 0.50 to 2.0 percent and the enhancement was significant ($P \leq 0.05$). The increase in loaf volume might be due to better retention of gases in bread during fermentation and baking because of addition of surface active reagent (SSL). **Kaur et al (2006)** reported increase loaf volume with incorporation of 10 percent Indian gluten powder and 0.5 percent surface active reagent (SSL) in bread.

The results showed an increase (3.129 to 3.139 mlg^{-1}) in specific loaf volume on increasing the level of surface active reagent (SSL) from0.50 to 2.0 percent and the increase in specific loaf volume of bread was significant ($P \leq 0.05$).

Table no- 4.42 Effect of surface active reagent (SSL) on the physical characteristics of defatted soy flour fortified bread

Proportion of SAR (%)	Loaf weight (gm)	Loaf volume (ml)	Specific loaf volume (mlg-1)	Slice height (cm)	Loaf height	Compression force in kg (TPA)
0	160.92	503.67	3.129	6.83	7.01	2.306
0.50	161.09	504.52	3.131	6.90	7.06	2.220
1.0	161.27	505.67	3.135	6.97	7.11	2.010
1.50	161.40	506.45	3.136	7.05	7.17	1.928
2.0	161.70	507.58	3.139	7.12	7.22	1.821
Mean	161.28	505.57	3.134	6.98	7.114	2.057
CD ($P\leq 0.05$)	0.15	0.32	0.001	0.05	0.03	0.101

Values are average of three determinations

Kaur et al., (2006) also reported an increase in specific loaf volume with incorporation of 10 percent Indian gluten powder and 0.5 percent surface active reagent (SSL) in bread.

The results revealed an increase in slice height of bread on increasing in surface active reagent (SSL) level from 0.5 to 2.0 percent. The slice height of bread was minimum (6.83 cm) and maximum (7.12 cm) of control sample and 2.0 percent surface active reagent (SSL), respectively. The slice height of bread showed an increase on increasing the level of (SSL) and the variation in slice height was significant ($P \leq 0.05$). **Kaur et al (2006)** reported an increase slice height with incorporation of 10 percent Indian gluten powder and 0.5 percent surface active reagent (SSL) in bread.

The results showed an increasing trend in loaf height of soy flour incorporated bread on increasing the level of surface active reagent (SSL). The values of loaf height increased from 7.01 to 7.22 cm on increasing the level of surface active reagent level from 0.0 to 2.0 percent. The increase in loaf height of bread was found significant ($P \leq 0.05$) with increase in surface active reagent (SSL) in bread. **Kaur et al., (2006)** reported similar result on adding 0.5 percent surface active reagent (SSL) with 10 percent gluten powder in bread.

The results of texture profile analysis of defatted soy bread showed a decrease in hardness on increasing the level of surface active reagent (SSL). The values of hardness were maximum (2.306 kg) and minimum (1.821 kg) for control and 2.0 percent surface active reagent (SSL) level, respectively. The decrease in hardness was proportionate and significant ($P \leq 0.05$) with an increase in surface active reagent (SSL) level.

4.3.4 Chemical composition of white flour and defatted soy flour incorporated bread

The results of chemical composition (moisture, protein, fat, ash, crude fibre, carbohydrate, calcium, phosphorus, and iron) of white flour and defatted soy flour incorporated bread are presented in Table -4.43. Defatted soy flour was incorporated in bread at 0, 5, 10, 15 and 20 percent level.

The moisture content of bread increased from 30.60 to 35.04 percent with incorporation of defatted soy flour from 0 to 20 percent, respectively and the increase in moisture content was significant ($P \leq 0.05$). Similar results were obtained by **Ballester and Cerda, et al (1988)** who reported an increase in moisture content from 36.0 to 37.5 percent with incorporation of sweet lupin flour (6 to 12 percent) in white flour. The increase in moisture content of defatted soy flour fortified bread might be due to increase in the amount of crude fiber which absorbed more moisture.

The protein content increased proportionately from 9.64 to 13.75 percent with increase in soy flour from 0 to 20 percent. The increase in protein content was significant ($P \leq 0.05$). Similar results were obtained by **Hoonda (2005) and Jood et al., (2006)** who reported an increase in protein content in bread fortified with soy flour and barley flour, respectively. The increase in protein content of defatted soy flour incorporated bread might be due to the presence of higher amount of protein in defatted soy flour.

From the result presented in Table 4.43, it is revealed that the fat content of bread proportionately increased from 0.69 to 0.91 percent with increase in defatted soy flour from 0 to 20 percent in bread. The values of fat content was non significant upto 10 percent thereafter a significant ($P \leq 0.05$) increase was observed. **Dhingra and Jood et al., (2006)** also observed an increase in fat content of bread fortified with barley flour (5 to 20 percent).The lower percent of fat in defatted soy flour fortified bread was attributed to lower fat content of defatted soy flour.

The ash content was minimum (0.58 percent) for control bread and maximum (0.72 percent) for 20 percent defatted soy flour fortified bread. The increase was nonsignificant upto 10 percent level of defatted soy flour thereafter the increase was significant ($P \leq 0.05$). **Ballester and Cerda, et al (1988)** also observed an increase in ash content of bread fortified with sweet lupin flour.

The control bread had 0.29 percent crude fibre content which increased to 0.47 percent with incorporation of 20 percent defatted soy flour . The values of crude fibre content was nonsignificant upto 10 percent thereafter a significant ($P \leq 0.05$) increase was observed. **Dhingra and Jood (2006)** reported similar increasing trend in crude fibre of bread fortified with barley flour. The increment in crude fibre content of defatted soy flour fortified bread was due to the fact that refined wheat flour (maida) had lower amount of crude fibre(0.29) because of partial removal of bran during milling, but defatted soy flour had higher content of crude fibre(3.80), resulting in increase in crude fibre content of bread.

Table no-4.43 Chemical composition of white flour and defatted soy flour incorporated bread

Proportion of defatted soy flour	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude Fibre (%)	Carbohydrate (%)	Calcium (Mg/100 g)	Phosphorus (Mg/100g)	Iron (mg/100g)
100:00	30.6	9.64	0.69	0.58	0.29	58.20	30.10	137.0	2.48
95:05	31.53	10.1	0.73	0.61	0.33	56.39	32.13	145.01	2.55
90:10	32.62	11.18	0.78	0.64	0.37	54.37	34.15	153.47	2.62
85:15	33.84	12.46	0.84	0.68	0.42	51.69	36.21	160.94	2.66
80:20	35.04	13.75	0.91	0.72	0.47	49.02	38.23	168.41	2.71
Mean	32.78	11.42	0.79	0.64	0.37	53.93	34.16	153.07	2.604
CD at 5 % level	0.46	0.15	0.09	0.06	0.08	0.24	0.19	0.56	0.04

Values are average of three determinations

The results revealed a gradual decrease in carbohydrate content in defatted soy flour incorporated bread. There was a significant ($P \leq 0.05$) decrease in carbohydrate content on increasing the amount of defatted soy flour. Control bread had (58.20 percent) carbohydrate content and 20 percent soy bread had (49.02 percent) carbohydrate content. The decrease in carbohydrate content of defatted soy flour fortified bread was attributed due to the lesser amount of carbohydrates in defatted soy flour.

The results from the Table- 4.43, revealed an increase in calcium content of soy flour incorporated bread. The calcium content of bread increased from 30.10 percent (control) to 38.23 percent with 20 percent incorporation of defatted soy flour in bread. The increase in calcium content of bread was significant ($P \leq 0.05$). Similar findings were obtained by **Jood (2006) and Singh et al., (2000)** who observed an increase in calcium content with incorporation of soy flour in bread and biscuits. The increase in calcium content defatted soy flour fortified bread may be due to the higher content of calcium in defatted soy flour.

The control breads had lowest phosphorus content (137.00 mg/100g) and 20 percent defatted soy flour incorporated bread had highest phosphorus content (168.41 mg/100g). There was a significant ($P \leq 0.05$) increase in phosphorus content of bread with incorporation of defatted soy flour. The increase in phosphorus content of defatted soy flour incorporated bread was attributed to the higher amount of phosphorus in defatted soy flour.

The results revealed an increase in iron content of defatted soy flour incorporated bread. The iron content in control bread (2.48 mg/100g) increased up to (2.71 mg/100g) in 20 percent defatted soy flour incorporated bread. There was a significant ($P \leq 0.05$) increase in iron content of defatted soy flour fortified bread. The increase iron content in defatted soy flour incorporated bread may be due to higher content of iron in defatted soy flour.

4.3.5 Organoleptic characteristics of bread prepared from blends

4.3.5.1 Effect of defatted soy flour on sensory characteristics of bread

The mean sensory score for crust colour, crumb colour, grain size uniformity (texture), taste, flavour and over all acceptability of bread made from blends of defatted soy flour and white flour were presented in Table- 4.44 to 4.49, respectively.

The results present in Table-4.44, indicated a decreasing trend in crust colour of bread with increase in level of defatted soy flour. However the decrease in crust colour upto 10 percent was non-significant thereafter a significant ($P \leq 0.05$) decrease in crust colour was observed. The bread prepared with 20 percent level incorporated defatted soy flour bread was in acceptable range for crust colour.

Effect of defatted soy flour on Sensory characteristics of bread

Table no-4.44 Sensory score of crust colour of soy fortified flour incorporated bread

Panelists	Proportion of defatted soy flour				
	0	**5**	**10**	**15**	**20**
1	8.14	8.02	7.77	6.78	6.15
2	8.28	8.13	7.85	6.82	6.26
3	8.32	8.20	7.96	6.92	6.32
4	8.24	8.10	7.83	6.82	6.22
5	8.12	7.95	7.65	6.70	6.09
6	8.34	8.20	7.92	6.91	6.30
7	8.21	8.07	7.80	6.80	6.20
8	8.07	7.88	7.69	6.66	6.09
9	8.24	8.10	7.83	6.82	6.22
10	8.14	8.05	7.70	6.75	6.14
Mean	8.21	8.07	7.8	6.8	6.2
CD at 5% level	0.44				

Table no-4.45 Sensory score of Crumb Colour of soy fortified flour incorporated bread

Panelists	Proportion of defatted soy flour				
	0	**5**	**10**	**15**	**20**
1	8.03	7.90	7.77	6.38	5.86
2	8.17	8.01	7.85	6.42	5.96
3	8.21	8.08	7.96	6.52	6.02
4	8.13	7.98	7.83	6.42	5.92
5	8.01	7.83	7.65	6.31	5.80
6	8.23	8.08	7.92	6.50	5.99
7	8.10	7.95	7.80	6.40	5.90
8	7.96	7.77	7.69	6.27	5.79
9	8.13	7.98	7.83	6.42	5.92
10	8.03	7.93	7.70	6.35	5.84
Mean	8.1	7.95	7.8	6.4	5.9
CD at 5% level	0.301				

Table no-4.46 Sensory score of Texture(grain size) of soy fortified flour incorporated bread

Panelists	Proportion of defatted soy flour				
	0	5	10	15	20
1	7.93	7.85	7.23	5.59	4.86
2	8.07	7.96	7.30	5.62	4.95
3	8.11	8.03	7.41	5.70	5.00
4	8.03	7.93	7.29	5.62	4.92
5	7.91	7.78	7.12	5.52	4.82
6	8.13	8.03	7.38	5.69	4.98
7	8.00	7.90	7.26	5.60	4.90
8	7.86	7.72	7.15	5.48	4.81
9	8.03	7.93	7.29	5.62	4.92
10	7.93	7.88	7.17	5.56	4.85
Mean	8.0	7.9	7.26	5.6	4.9
CD at 5%	0.74				

Table no- 4.47 Sensory score of Taste of defatted soy fortified flour incorporated bread

Panelists	Proportion of defatted soy flour				
	0	5	10	15	20
1	8.11	8.03	7.98	7.02	6.02
2	8.25	8.14	8.06	7.07	6.12
3	8.29	8.21	8.18	7.17	6.18
4	8.21	8.11	8.04	7.07	6.08
5	8.09	7.96	7.85	6.94	5.96
6	8.31	8.21	8.14	7.15	6.16
7	8.18	8.08	8.01	7.04	6.06
8	8.04	7.89	7.89	6.89	5.95
9	8.21	8.11	8.04	7.07	6.08
10	8.11	8.06	7.91	6.99	6.00
Mean	8.18	8.08	8.01	7.04	6.06
CD at 5%	0.18				

Dhingra and Jood (2004) reported similar decrease in crust colour scores from 5 to 20 percent defatted soy flour incorporation.

The results present in Table-4.45, indicated decreasing trend in mean sensory score of crumb colour of bread on increasing the level of defatted soy flour (0 to 20 percent). However the decrease upto 10 percent was non-significant thereafter the variation was significant ($P \leq 0.05$). The mean crumb colour scores for defatted soy flour incorporated bread was in acceptable range upto 15 percent level. **Dhingra and Jood et al (2004)** reported similar results for variation in crumb colour.

From the results presented in Table-4.46, it is revealed that a decreasing trend in the mean scores of texture of bread on increasing the level of defatted soy flour and the variation was significant ($P \leq 0.05$) after 10 percent level. The bread upto 10 percent level of defatted soy flour were acceptable range. **Dhingra and Jood (2004)** reported similar decrease in texture scores from 5 to 20 percent defatted soy flour incorporation.

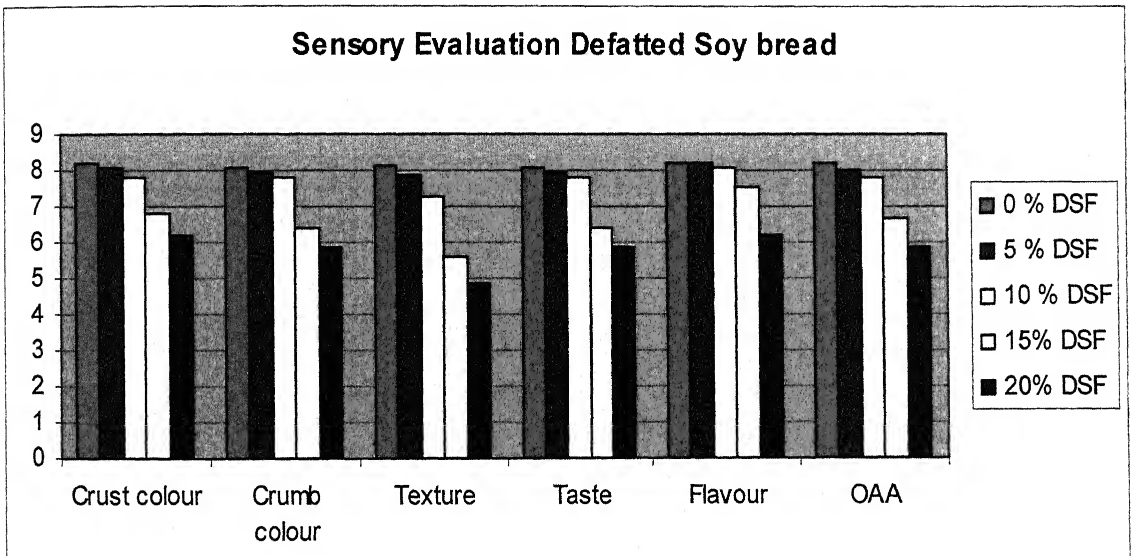
The results presented in Table -4.47, showed a decrease in mean sensory score for taste of bread with increase in incorporation level of defatted soy flour (0 to 10 percent). However, the decrease upto 10 percent was non significant thereafter a significant ($P \leq 0.05$) decrease was observed. The bread with 15 and 20 percent soy flour scored 7.04 and 6.06 respectively, which was in acceptable range. **Dhingra** and **Jood (2004)** reported similar decrease in taste scores from 5 to 20 percent defatted soy flour incorporation.

Table no- 4.48 Sensory score of flavour of soy fortified flour incorporated bread

Panelists	Proportion of defatted soy flour				
	0	**5**	**10**	**15**	**20**
1	8.16	8.12	8.07	7.52	6.17
2	8.30	8.23	8.15	7.57	6.28
3	8.34	8.30	8.27	7.68	6.34
4	8.26	8.20	8.13	7.57	6.24
5	8.14	8.05	7.94	7.43	6.11
6	8.36	8.30	8.23	7.66	6.32
7	8.23	8.17	8.10	7.54	6.22
8	8.09	7.98	7.98	7.38	6.11
9	8.26	8.20	8.13	7.57	6.24
10	8.16	8.15	8.00	7.48	6.16
Mean	8.23	8.17	8.1	7.54	6.22
CD at 5%	0.197				

Table no-4.49 Sensory score of OAA of soy fortified flour incorporated bread

Panelists	Proportion of defatted soy flour				
	0	**5**	**10**	**15**	**20**
1	8.10	7.98	7.76	6.65	5.81
2	8.24	8.09	7.84	6.69	5.91
3	8.28	8.16	7.95	6.79	5.96
4	8.20	8.06	7.82	6.69	5.87
5	8.08	7.91	7.64	6.57	5.75
6	8.30	8.16	7.91	6.78	5.94
7	8.17	8.03	7.79	6.67	5.85
8	8.03	7.84	7.68	6.53	5.74
9	8.20	8.06	7.82	6.69	5.87
10	8.10	8.01	7.70	6.63	5.80
Mean	8.17	8.03	7.79	6.67	5.85
CD at 5%	0.423				



Sensory Evaluation Defatted Soy bread
9
8
7
6
5
4
3
2
1
0
Crust colour
Crumb colour
Texture
Taste
Flavour
OAA
0 % DSF
5 % DSF
10 % DSF
15% DSF
20% DSF

Fig no- 4.6

The results (Table- 4.48) of present investigation indicated a decrease in flavour of bread with an increase in incorporation level of defatted soy flour (0 to 20 percent), however the decrease upto 10 percent was non significant thereafter a significant ($P \leq 0.05$) decrease was observed. The incorporation of defatted soy flour upto 20 percent produced bread was in acceptable range. **Dhingra and Jood (2004)** reported similar decrease in flavour scores from 5 to 20 percent defatted soy flour incorporation.

The incorporation of defatted soy flour upto 10 percent level, showed a non significant variation in the mean sensory score for over all acceptability, thereafter a significant ($P \leq 0.05$) decrease was observed. **Jood et al., (2004)** reported similar decrease in over all acceptability from 5 to 20 percent defatted soy flour incorporation.

On the basis of sensory evaluation, 10 percent incorporation of defatted soy flour was optimized to prepare bread for further studies.

4.3.5.2 Effect of blending of gluten powder on sensory characteristic of defatted soy flour incorporated bread

The effect of blending of gluten on sensory characteristics such as crust colour, crumb colour, texture, flavour and over all acceptability of defatted soy flour incorporated bread was given in Table – 4.50 to 4.55, respectively.

The blending of gluten enhanced the mean sensory score (Table- 4.50) for crust colour was maximum 7.22 of the bread prepared with 4 percent inclusion of gluten powder. The control and 2 percent gluten powder added bread was significantly ($P \leq 0.05$) lower in crust colour. Further variation in crust colour of bread with 6 percent and 8 percent inclusion of gluten powder was non significant.

The mean sensory score (Table- 4.51) for crumb colour was maximum 7.18 of the bread prepared with 4 percent inclusion of gluten powder level. However control and 2 percent gluten powder included bread were significantly ($P \leq 0.05$) inferior in crumb colour and other combination (6 and 8 percent) were non significant.

The mean sensory score (Table- 4.52) for texture was maximum (7.40) of the bread prepared with 4 percent incorporation of gluten powder level. However control and 2 percent gluten powder incorporated bread were significantly ($P \leq 0.05$) lower in texture and the variation with 6 to 8 percent gluten powder added bread was non significant. The increase in gluten powder dispersed the protein in the bread leading to a soft product.

Effect of Gluten Powder on Sensory characteristics of defatted soy flour incorporated bread

Table no- 4.50 **On Crust Colour**

Panelists	Proportion of Gluten powder in 10 percent defatted soy flour incorporated optimized bread				
	0%	**2%GP**	**4%GP**	**6% GP**	**8%GP**
1.00	6.54	6.86	7.19	7.10	7.03
2.00	6.66	6.95	7.26	7.15	7.15
3.00	6.69	7.01	7.37	7.25	7.22
4.00	6.62	6.93	7.25	7.15	7.11
5.00	6.53	6.80	7.08	7.02	6.96
6.00	6.71	7.01	7.33	7.23	7.19
7.00	6.60	6.90	7.22	7.12	7.08
8.00	6.49	6.74	7.11	6.97	6.95
9.00	6.62	6.93	7.25	7.15	7.11
10.00	6.54	6.88	7.13	7.07	7.01
Mean	6.60	6.90	7.22	7.12	7.08
CD at 5%	0.19				

Table no-4.51 **On Crumb Colour**

Panelists	Proportion of Gluten powder in 10 percent defatted soy flour incorporated optimized bread				
	0%	**2%GP**	**4%GP**	**6% GP**	**8%GP**
1.00	6.83	6.99	7.15	7.09	7.00
2.00	6.95	7.08	7.22	7.14	7.12
3.00	6.98	7.14	7.33	7.24	7.19
4.00	6.92	7.06	7.21	7.14	7.08
5.00	6.81	6.93	7.04	7.01	6.93
6.00	7.00	7.14	7.29	7.22	7.16
7.00	6.89	7.03	7.18	7.11	7.05
8.00	6.77	6.87	7.07	6.96	6.92
9.00	6.92	7.06	7.21	7.14	7.08
10.00	6.83	7.01	7.09	7.06	6.98
Mean	6.89	7.03	7.18	7.11	7.05
CD at 5%	0.13				

Table no-4.52 On Texture

Panelists	Proportion of Gluten powder in 10 percent defatted soy flour incorporated optimized bread				
	0%	2%GP	4%GP	6% GP	8%GP
1.00	6.49	6.77	7.37	7.32	7.25
2.00	6.61	6.86	7.45	7.37	7.37
3.00	6.64	6.92	7.55	7.47	7.44
4.00	6.57	6.84	7.43	7.37	7.33
5.00	6.48	6.71	7.26	7.23	7.17
6.00	6.65	6.92	7.52	7.46	7.42
7.00	6.55	6.81	7.40	7.34	7.30
8.00	6.44	6.65	7.29	7.19	7.17
9.00	6.57	6.84	7.43	7.37	7.33
10.00	6.49	6.79	7.31	7.29	7.23
Mean	6.55	6.81	7.40	**7.34**	**7.30**
CD at 5%	0.13				

Table no-4.53 On Taste

Panelists	Proportion of Gluten powder in 10 percent defatted soy flour incorporated optimized bread				
	0%	2%GP	4%GP	6%GP	8%GP
1.00	7.04	7.18	7.36	7.35	7.28
2.00	7.16	7.27	7.44	7.40	7.40
3.00	7.20	7.33	7.54	7.51	7.47
4.00	7.13	7.25	7.42	7.40	7.36
5.00	7.02	7.11	7.25	7.26	7.20
6.00	7.21	7.33	7.51	7.49	7.45
7.00	7.10	7.22	7.39	7.37	7.33
8.00	6.98	7.05	7.28	7.22	7.20
9.00	7.13	7.25	7.42	7.40	7.36
10.00	7.04	7.20	7.30	7.32	7.26
Mean	7.10	7.22	7.39	7.37	7.33
CD at 5%	0.16				

Table no-4.54 On Flavour

Panelists	Proportion of Gluten powder in 10 percent defatted soy flour incorporated optimized bread				
	0%	2%GP	4%GP	6% GP	8%GP
1.00	6.74	6.96	7.17	7.08	7.04
2.00	6.86	7.05	7.24	7.13	7.16
3.00	6.89	7.11	7.35	7.23	7.23
4.00	6.82	7.03	7.23	7.13	7.12
5.00	6.73	6.90	7.06	7.00	6.97
6.00	6.91	7.11	7.31	7.21	7.20
7.00	6.80	7.00	7.20	7.10	7.09
8.00	6.68	6.84	7.09	6.95	6.96
9.00	6.82	7.03	7.23	7.13	7.12
10.00	6.74	6.98	7.11	7.05	7.02
Mean	6.80	7.00	7.20	7.10	7.09
CD at 5%	0.45				

Table no-4.55 Over All Acceptability

Panelists	Proportion of Gluten powder in 10 percent defatted soy flour incorporated optimized bread				
	0%	2%GP	4%GP	6%GP	8%GP
1.00	6.72	6.94	7.26	7.18	7.13
2.00	6.84	7.03	7.33	7.23	7.25
3.00	6.87	7.09	7.44	7.33	7.32
4.00	6.80	7.01	7.32	7.23	7.21
5.00	6.71	6.88	7.15	7.09	7.06
6.00	6.89	7.09	7.41	7.31	7.29
7.00	6.78	6.98	7.29	7.20	7.18
8.00	6.66	6.82	7.18	7.05	7.05
9.00	6.80	7.01	7.32	7.23	7.21
10.00	6.73	6.97	7.19	7.15	7.11
Mean	6.78	6.98	7.29	7.20	7.18
CD at 5%	0.17				

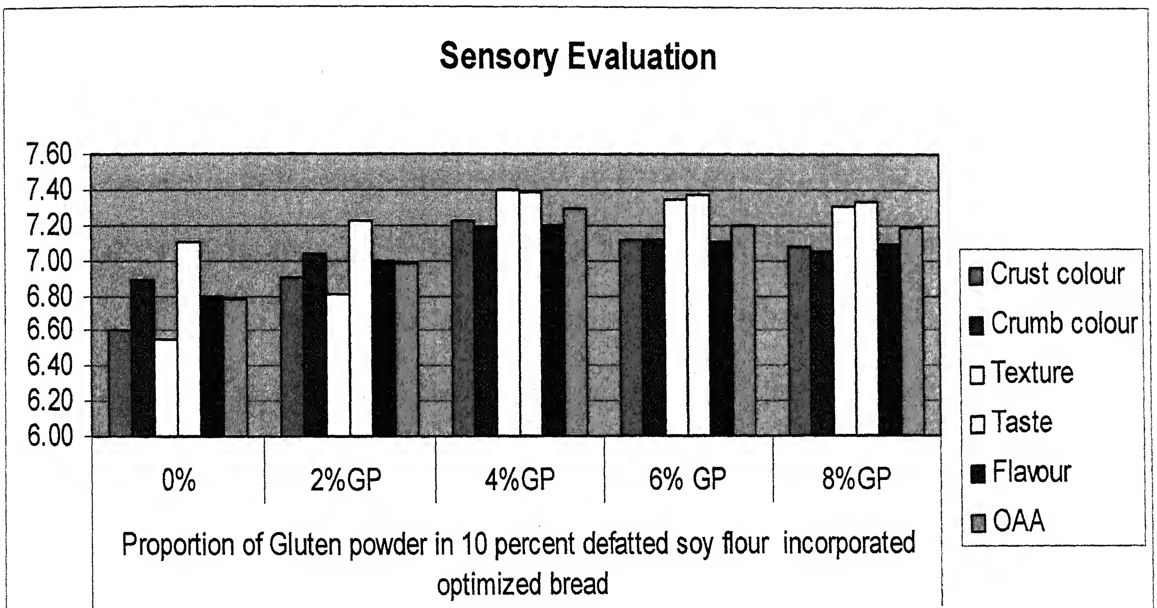

Sensory Evaluation
7.60
7.40
7.20
7.00
6.80
6.60
6.40
6.20
6.00
0%
2%GP
4%GP
6% GP
8%GP
Proportion of Gluten powder in 10 percent defatted soy flour incorporated optimized bread
Crust colour
Crumb colour
Texture
Taste
Flavour
OAA

Fig no- 4.7

The mean sensory score for taste was maximum (7.39) of the bread prepared with 4 percent inclusion of gluten powder. The increase or decrease in gluten powder lowered the mean sensory scores. The variation in mean sensory score with control and 2 percent gluten added bread was significant ($P \leq 0.05$) and with 6 and 8 percent gluten was nonsignificant.

The mean sensory score for flavour (7.20) was maximum of 4 percent gluten powder incorporated bread. The increase or decrease in gluten powder level decreased the mean sensory scores and the variation was nonsignificant. The bread with all combination (0, 2, 4, 6, and 8 percent) was in acceptable range of sensory evaluation.

The mean sensory score for over all acceptability was maximum (7.29) of the bread prepared with 4 percent incorporation of gluten powder. The variation in over all acceptability of bread with 6 and 8 percent inclusion of gluten powder was non significant and with other combination were significant ($P \leq 0.05$).

On the basis of above results, it can be concluded that 4 percent gluten powder level was optimum for 10 percent defatted soy flour incorporated bread. So it was selected for further investigation.

4.3.5.3 Effect of surface active reagent (Sodium Stearoly-2-Lactylate) on sensory characteristics of defatted soy flour incorporated bread.

The effect of surface active reagent (SSL) level on sensory characteristics of (10 percent defatted soy flour and 4 percent gluten powder) included bread are given in Table - 4.56 to 4.61, respectively.

The maximum mean sensory scores for crust colour (7.30) was obtained with 1.0 percent surface active reagent (SSL) incorporated bread. The increase or decrease in the level of surface active reagent (SSL) lowered the mean sensory scores significantly ($P \leq 0.05$).

The mean sensory scores for crumb colour was maximum (7.29) obtained with 1.0 percent surface active reagent (SSL) incorporated bread. On increasing and decreasing the level of surface active reagent, the variation in mean sensory score of crumb colour was significant ($P \leq 0.05$).

The mean sensory scores for texture were maximum 7.60 with 1.0 percent level of surface active reagent. The bread prepared with other combinations (control, 0.50, 1.5 and 2.0 percent) of surface active reagent (SSL) differed significantly ($P \leq 0.05$), though all the samples were in acceptable range for texture.

The mean sensory score of taste was maximum (7.58) for bread made by adding 1.0 percent level of surface active reagent (SSL). The variation in taste of bread with 0.5 and 1.5 percent level of surface active reagent (SSL) was nonsignificant, however the samples with 2 percent level of (SSL) and control differed significantly ($P \leq 0.05$).

Effect of surface active reagent (Sodium Stearoly -2- Lactylate) on sensory characteristics of defatted soy flour incorporated bread

Table no- 4.56 **On Crust Colour**

Panelists	Proportion of surface active reagent (SSL) in 10 percent defatted soy flour and 4 percent gluten powder incorporated optimized bread				
	0%	0.5%SAR	1.0%SAR	1.5%SAR	2.0%SAR
1.00	7.16	7.21	7.27	7.23	7.15
2.00	7.28	7.30	7.34	7.28	7.27
3.00	7.32	7.37	7.45	7.38	7.34
4.00	7.25	7.28	7.33	7.28	7.23
5.00	7.14	7.14	7.16	7.14	7.08
6.00	7.33	7.37	7.42	7.37	7.31
7.00	7.22	7.25	7.30	7.25	7.20
8.00	7.10	7.08	7.19	7.10	7.07
9.00	7.25	7.28	7.33	7.28	7.23
10.00	7.16	7.23	7.21	7.20	7.13
Mean	7.22	7.25	7.30	7.25	7.20
CD at 5%	0.04				

Table no-4.57 **On Crumb Colour**

Panelists	Proportion of surface active reagent (SSL) in 10 percent defatted soy flour and 4 percent gluten powder incorporated optimized bread				
	0%	0.5% SAR	1.0% SAR	1.5% SAR	2.0% SAR
1.00	7.12	7.18	7.26	7.21	7.12
2.00	7.24	7.27	7.33	7.26	7.24
3.00	7.28	7.33	7.44	7.36	7.31
4.00	7.21	7.25	7.32	7.26	7.20
5.00	7.10	7.11	7.15	7.12	7.05
6.00	7.29	7.33	7.41	7.35	7.28
7.00	7.18	7.22	7.29	7.23	7.17
8.00	7.06	7.05	7.18	7.08	7.04
9.00	7.21	7.25	7.32	7.26	7.20
10.00	7.12	7.20	7.20	7.18	7.10
Mean	7.18	7.22	7.29	7.23	7.17
CD at 5%	0.05				

Table no-4.58 **On Texture (grain size)**

Panelists	Proportion of surface active reagent (SSL) in 10 percent defatted soy flour and 4 percent gluten powder incorporated optimized bread				
	0%	0.5% SAR	1.0% SAR	1.5% SAR	2.0% SAR
1.00	7.34	7.44	7.53	7.39	7.44
2.00	7.46	7.56	7.67	7.51	7.56
3.00	7.52	7.62	7.72	7.57	7.62
4.00	7.43	7.53	7.63	7.48	7.53
5.00	7.29	7.39	7.49	7.34	7.39
6.00	7.52	7.62	7.72	7.57	7.62
7.00	7.40	7.50	7.60	7.45	7.50
8.00	7.25	7.34	7.44	7.29	7.34
9.00	7.43	7.53	7.63	7.48	7.53
10.00	7.37	7.47	7.57	7.42	7.47
Mean	7.40	7.50	7.60	7.45	7.50
CD at 5%	0.09				

Table no-4.59 **On Taste**

Panelists	Proportion of surface active reagent (SSL) in 10 percent defatted soy flour and 4 percent gluten powder incorporated optimized bread				
	0%	0.5%SAR	1.0%SAR	1.5%SAR	2.0%SAR
1.00	7.34	7.41	7.55	7.44	7.25
2.00	7.46	7.51	7.63	7.49	7.37
3.00	7.50	7.58	7.74	7.60	7.44
4.00	7.43	7.49	7.61	7.49	7.33
5.00	7.32	7.35	7.43	7.35	7.17
6.00	7.52	7.58	7.70	7.58	7.42
7.00	7.40	7.46	7.58	7.46	7.30
8.00	7.27	7.29	7.47	7.30	7.17
9.00	7.43	7.49	7.61	7.49	7.33
10.00	7.34	7.44	7.49	7.41	7.23
Mean	7.40	7.46	7.58	7.46	7.30
CD at 5%	0.12				

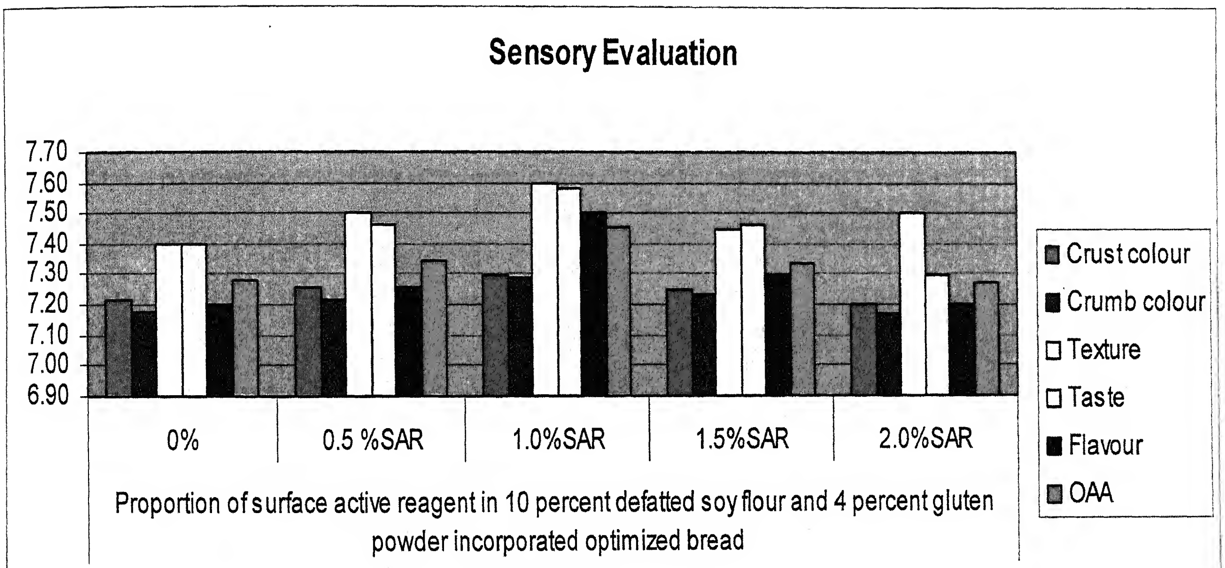

Sensory Evaluation
7.70
7.60
7.50
7.40
7.30
7.20
7.10
7.00
6.90
0%
0.5 %SAR
1.0%SAR
1.5%SAR
2.0%SAR
Proportion of surface active reagent in 10 percent defatted soy flour and 4 percent gluten powder incorporated optimized bread
Crust colour
Crumb colour
Texture
Taste
Flavour
OAA

Fig no- 4.8

Table no-4.60 On Flavour

Panelists	Proportion of surface active reagent (SSL) in 10 percent defatted soy flour and 4 percent gluten powder incorporated optimized bread				
	0%	0.5%SAR	1.0%SAR	1.5%SAR	2.0%SAR
1.00	7.14	7.22	7.47	7.28	7.15
2.00	7.26	7.31	7.55	7.33	7.27
3.00	7.30	7.38	7.66	7.43	7.34
4.00	7.23	7.29	7.53	7.33	7.23
5.00	7.12	7.15	7.35	7.19	7.08
6.00	7.31	7.38	7.62	7.42	7.31
7.00	7.20	7.26	7.50	7.30	7.20
8.00	7.08	7.09	7.39	7.15	7.07
9.00	7.23	7.29	7.53	7.33	7.23
10.00	7.14	7.24	7.41	7.25	7.13
Mean	7.20	7.26	7.50	7.30	7.20
CD at 5%	0.24				

Table no-4.61 On Over All Acceptability

Panelists	Proportion of surface active reagent (SSL) in 10 percent defatted soy flour and 4 percent gluten powder incorporated optimized bread				
	0%	0.5%SAR	1.0%SAR	1.5%SAR	2.0%SAR
1.00	7.22	7.29	7.42	7.31	7.22
2.00	7.34	7.40	7.50	7.37	7.34
3.00	7.38	7.46	7.60	7.47	7.41
4.00	7.31	7.37	7.48	7.36	7.30
5.00	7.19	7.23	7.32	7.23	7.15
6.00	7.40	7.46	7.57	7.45	7.39
7.00	7.28	7.34	7.45	7.34	7.27
8.00	7.15	7.17	7.34	7.19	7.14
9.00	7.31	7.37	7.48	7.36	7.30
10.00	7.22	7.32	7.38	7.29	7.21
Mean	7.28	7.34	7.45	7.34	7.27
CD at 5%	0.07				

The flavour score was maximum 7.50 for bread made from (1.0 percent) level of surface active reagent (SSL). The variation in flavour of bread with 0.5 and 1.5 percent level of surface active reagent was non significant, however the control and with 2 percent level of surface active reagent differed significantly ($P \leq 0.05$).

The mean sensory score for over all acceptability with surface active reagent level were found in acceptable range. The highest score (7.45) was obtained with 1.0 percent level of surface active reagent (SSL). On increasing and decreasing the level of surface active reagent, the variation in over all acceptability was significant ($P \leq 0.05$) with all other samples. Hence, 1.0 percent surface active reagent (SSL) was found optimum.

4.3.6 Effect of storage period on moisture content of defatted soy flour incorporated bread (At refrigeration temperature and room temperature)

The results of the effect of storage at room temperature (35-37°C) and refrigeration temperature (4°C) on moisture content were evaluated at an interval of one day for one weak of defatted soy flour optimized bread is presented in Table-4.62. The result of present investigation indicated a decrease in moisture content of bread with increase the storage time at ambient temperature (35-37°C) and refrigerated temperature (4°C) for one weak. However the decrease in moisture at room temperature up to 3 days and 5 days at refrigeration temperature was non significant thereafter a significant ($P \leq 0.05$) variation was found at both temperature i.e. room and refrigeration. **Sharma et al (1999)** reported similar decrease in moisture and increase in instron force, indicating decreased softness of the product (flat bread, bread, and chapatti) quality, when stored at 37 °C for 3 days and 4°C for 5 days.

Table no- 4. 62 Effect of storage on moisture content of optimized sample (At refrigerated temperature and room temperature)

Storage Period (No of days)	Moisture content	
	Refrigeration Temperature (4°C)	Room Temperature (35-37 °C)
0	37.30	37.30
1	36.92	36.60
2	36.50	35.88
3	35.98	35.17
4	35.40	34.65
5	34.95	33.83
6	34.62	32.94
7	32.92	32.04
Mean	35.57	34.80
CD at 5 % level	2.35	2.13

Table no- 4. 63 Effect of storage on textural profile analysis of optimized sample (At refrigerated temperature and room temperature)

Storage Period (No of days)	Force in kg	
	Refrigeration Temperature (4°C)	Room Temperature (35-37 °C)
0	2.296	2.482
1	3.401	3.571
2	4.122	4.342
3	5.266	5.452
4	6.239	6.408
5	7.134	7.701
6	8.247	8.692
7	9.671	9.921
Mean	5.854	6.071
CD at 5 % level	1.09	1.201

4.3.7 Effect of storage period on texture profile analysis of defatted soy flour optimized bread (At refrigerated temperature and room temperature)

The result of the effect of storage time and temperature on textural profile analysis (force in kg) of 10 percent defatted soy flour incorporated bread are presented in Table -4.63.

The observations were made at an interval of 1 day for 7 days at both the temperature i.e. refrigerated temperature 4 °C and room temperature 35-37 °C. The results revealed an increase in the compression peak force (kg) of bread with an increase of storage period at both the temperature. The minimum and maximum compression force 2.296 and 9.671 kg respectively at refrigeration temperature and 2.482 and 9.921 kg respectively at room temperature. The variation in compression peak force was significant ($P \leq 0.05$) increase at both the temperature. The results indicated that the hardness is increasing with increase in storage time at both the temperature. The variation may be because of removal of moisture during storage and its effect on starch. The variation in hardness of bread stored at room temperature was more as compared to refrigeration temperature.

4.3.8 Effect of storage period on organoleptic characteristic of defatted soy flour optimized bread (at room and refrigeration temperature)

a) At ambient temperature (35-37^0 C)

The results of the effect of storage time at room temperature (35-37°C) on sensory parameters (crust colour, crumb colour, taste, flavour and over all acceptability) were evaluated at an interval of 1 day for one weak of soy flour optimized bread is presented in Table- 4.64 to 4.68.

The mean sensory score for crust colour of soy bread are presented in Table- 4.64. The result showed a decrease in crust colour of bread with increase the storage periods. The variation in crust colour score was non significant up to 3 days thereafter a significant ($P \leq 0.05$) variation was observed. However the mean sensory score for crust colour was in acceptable range upto 7 days of storage.

The results (Table- 4.65) of present investigation indicated a decrease in crumb colour of bread on increasing the storage periods. However, the decrease in crumb colour upto 3 days was non-significant thereafter a significant ($P \leq 0.05$) decrease in crumb colour was observed. The crumb colour was in acceptable range up to 7 days of storage period.

The results presented in Table -4.66, showed a decrease in mean sensory score for taste of bread with increase in storage periods at room temperature. The decrease upto 3 days was non significant thereafter a significant ($P \leq 0.05$) decrease was observed

Table no- 4.64 sensory score of crust colour of soy flour optimized bread at ambient temperature (35-37^{0}C)

Panelists	Storage periods (days)							
	0	1	2	3	4	5	6	7
1	8.13	8.10	7.98	8.06	7.86	7.62	7.43	6.85
2	8.27	8.21	8.06	8.11	8.00	7.76	7.55	6.97
3	8.31	8.28	8.18	8.23	8.08	7.83	7.63	7.04
4	8.23	8.18	8.04	8.11	7.95	7.71	7.51	6.93
5	8.11	8.03	7.85	7.96	7.78	7.55	7.35	6.78
6	8.33	8.28	8.14	8.21	8.05	7.80	7.60	7.01
7	8.20	8.15	8.01	8.08	7.92	7.68	7.48	6.90
8	8.06	7.96	7.89	7.91	7.77	7.54	7.34	6.77
9	8.23	8.18	8.04	8.11	7.95	7.71	7.51	6.93
10	8.13	8.13	7.91	8.02	7.84	7.60	7.41	6.83
mean	8.2	8.15	8.01	8.08	7.92	7.68	7.48	6.9
CD at 5%	0.13							

Table no- 4.65 sensory score of crumb colour of soy flour optimized bread at ambient temperature (35-37^{0}C)

Panelists	storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.73	7.73	7.72	7.68	7.54	7.25	6.95	6.75
2	7.87	7.84	7.80	7.73	7.67	7.37	7.07	6.87
3	7.91	7.90	7.91	7.84	7.75	7.44	7.14	6.93
4	7.83	7.81	7.78	7.73	7.63	7.33	7.03	6.82
5	7.71	7.67	7.60	7.59	7.47	7.17	6.88	6.68
6	7.92	7.90	7.87	7.82	7.72	7.42	7.11	6.91
7	7.80	7.78	7.75	7.70	7.60	7.30	7.00	6.80
8	7.67	7.60	7.64	7.54	7.46	7.17	6.87	6.68
9	7.83	7.81	7.78	7.73	7.63	7.33	7.03	6.82
10	7.73	7.76	7.66	7.64	7.53	7.23	6.93	6.73
mean	7.8	7.78	7.75	7.7	7.6	7.3	7	6.8
CD at 5%	0.11							

Table no-4. 66 sensory score of taste of soy flour optimized bread at ambient temperature (35-37^{0}C)

Panelists	storage periods (days)							
	0	1	2	3	4	5	6	7
1	8.03	8.05	7.97	7.98	7.84	7.54	7.15	6.75
2	8.17	8.16	8.05	8.03	7.98	7.67	7.27	6.87
3	8.21	8.23	8.17	8.15	8.05	7.75	7.34	6.93
4	8.13	8.13	8.03	8.03	7.93	7.63	7.23	6.82
5	8.01	7.98	7.84	7.88	7.76	7.47	7.08	6.68
6	8.23	8.23	8.13	8.13	8.03	7.72	7.31	6.91
7	8.10	8.10	8.00	8.00	7.90	7.60	7.20	6.80
8	7.96	7.91	7.88	7.83	7.75	7.46	7.07	6.68
9	8.13	8.13	8.03	8.03	7.93	7.63	7.23	6.82
10	8.03	8.08	7.90	7.94	7.82	7.53	7.13	6.73
mean	8.1	8.1	8	8	7.9	7.6	7.2	6.8
CD at 5%	0.13							

Table no- 4.67 sensory score of flavour of soy flour optimized bread at ambient temperature (35-37^{0}C)

Panelists	storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.83	7.81	7.77	7.74	7.66	7.54	6.95	6.45
2	7.97	7.92	7.85	7.79	7.80	7.67	7.07	6.56
3	8.01	7.99	7.96	7.90	7.87	7.75	7.14	6.63
4	7.93	7.89	7.83	7.79	7.75	7.63	7.03	6.52
5	7.81	7.74	7.65	7.65	7.59	7.47	6.88	6.39
6	8.03	7.99	7.92	7.88	7.84	7.72	7.11	6.60
7	7.90	7.86	7.80	7.76	7.72	7.60	7.00	6.50
8	7.76	7.68	7.69	7.60	7.58	7.46	6.87	6.38
9	7.93	7.89	7.83	7.79	7.75	7.63	7.03	6.52
10	7.83	7.84	7.70	7.70	7.64	7.53	6.93	6.44
mean	7.9	7.86	7.8	7.76	7.72	7.6	7	6.5
CD at 5%	0.15							

Table no – 4.68 sensory score of over all acceptability of soy flour optimized bread at ambient temperature (35-37^{0}C)

Panelists	storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.93	7.93	7.87	7.86	7.78	7.57	7.19	6.99
2	8.07	8.04	7.95	7.91	7.92	7.70	7.31	7.11
3	8.11	8.11	8.06	8.02	7.99	7.78	7.38	7.18
4	8.03	8.01	7.93	7.91	7.87	7.66	7.27	7.07
5	7.91	7.86	7.75	7.76	7.71	7.50	7.12	6.92
6	8.13	8.11	8.03	8.01	7.96	7.75	7.36	7.15
7	8.00	7.98	7.90	7.88	7.84	7.63	7.24	7.04
8	7.86	7.79	7.78	7.72	7.70	7.49	7.11	6.91
9	8.03	8.01	7.93	7.91	7.87	7.66	7.27	7.07
10	7.93	7.96	7.80	7.82	7.76	7.56	7.17	6.97
mean	8	7.98	7.9	7.88	7.84	7.63	7.24	7.04
CD at 5%	0.13							

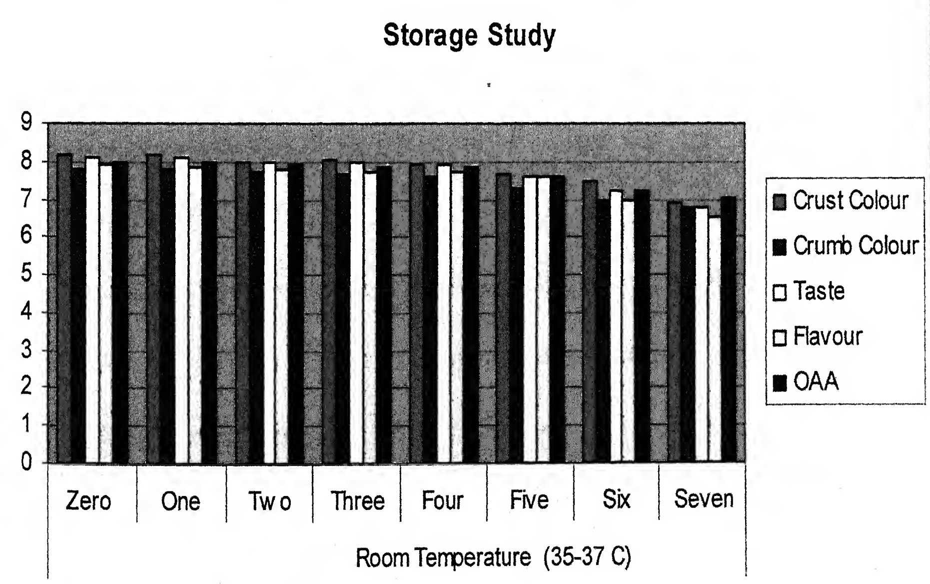


Fig no-4.9

The results (Table- 4.67) of present investigation indicated a decrease in flavour of bread with an increase in storage period. The decrease in the mean flavour scores up to 3 days was non significant thereafter a significant ($P \leq 0.05$) decrease in flavour was observed.

The results presented in Table- 4.68, depicted a decrease in over all acceptability of bread on increasing the storage period. The decrease in over all acceptability upto 3 days was non significant thereafter a significant ($P \leq 0.05$) decrease was observed. Similar decreasing trend was reported by **Sharma et al (1991)** when product stored for 3 days at 37^0C.

On the basis of the sensory evaluation, it is concluded that the bread may be stored successfully at 37 °C for 3 days.

b) At refrigeration temperature

The results of the effect of storage time at refrigeration temperature (4°C) on sensory parameters such as crust colour, crumb colour, taste, flavour and over all acceptability were evaluated at an interval of 1 day for one week of soy bread are presented in Table- 4.69 to 4.73.

The mean sensory score for crust colour of defatted soy flour optimized bread are presented in Table- 4.69. The result indicated a decreasing trend in crust colour of bread on increasing the storage periods. The variation in mean sensory score of crust colour of bread was non significant up to 5 days of storage thereafter a significant ($P \leq 0.05$) variation was observed. However the mean sensory score for crust colour was in acceptable range upto 7 days of storage.

Table no- 4. 69 sensory score of crust colour of soy flour optimized bread at refrigerated temperature (4^0C)

Panelists	storage periods (days)							
	0	1	2	3	4	5	6	7
1	8.13	8.11	8.11	8.10	8.04	7.94	7.64	7.25
2	8.27	8.22	8.19	8.15	8.18	8.08	7.78	7.37
3	8.31	8.29	8.31	8.27	8.26	8.16	7.85	7.44
4	8.23	8.19	8.17	8.15	8.13	8.03	7.73	7.33
5	8.11	8.04	7.98	8.00	7.96	7.86	7.57	7.17
6	8.33	8.29	8.27	8.25	8.23	8.13	7.82	7.42
7	8.20	8.16	8.14	8.12	8.10	8.00	7.70	7.30
8	8.06	7.97	8.02	7.95	7.95	7.85	7.56	7.17
9	8.23	8.19	8.17	8.15	8.13	8.03	7.73	7.33
10	8.13	8.14	8.04	8.06	8.02	7.92	7.62	7.23
mean	8.2	8.16	8.14	8.12	8.1	8	7.7	7.3
CD at 5%	0.21							

Table no- 4.70 sensory score of crumb colour of soy flour optimized bread at refrigerated temperature (4^oC)

Panelists	storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.76	7.78	7.77	7.64	7.58	7.57	7.15	6.75
2	7.90	7.89	7.85	7.69	7.71	7.70	7.27	6.87
3	7.94	7.95	7.96	7.80	7.79	7.78	7.34	6.93
4	7.86	7.86	7.83	7.69	7.67	7.66	7.23	6.82
5	7.74	7.71	7.65	7.55	7.51	7.50	7.08	6.68
6	7.95	7.95	7.92	7.78	7.76	7.75	7.31	6.91
7	7.83	7.83	7.80	7.66	7.64	7.63	7.20	6.80
8	7.70	7.65	7.69	7.50	7.50	7.49	7.07	6.68
9	7.86	7.86	7.83	7.69	7.67	7.66	7.23	6.82
10	7.76	7.81	7.70	7.60	7.57	7.56	7.13	6.73
mean	7.83	7.83	7.8	7.66	7.64	7.63	7.2	6.8
CD at 5%	0.21							

Table no- 4.71 sensory score of taste of soy flour optimized bread at refrigerated temperature (4°C)

Panelists	storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.96	7.96	7.97	7.88	7.84	7.77	7.44	6.75
2	8.10	8.07	8.05	7.93	7.98	7.91	7.57	6.87
3	8.14	8.14	8.17	8.05	8.05	7.98	7.65	6.93
4	8.06	8.04	8.03	7.93	7.93	7.86	7.53	6.82
5	7.94	7.89	7.84	7.78	7.76	7.70	7.37	6.68
6	8.16	8.14	8.13	8.03	8.03	7.95	7.62	6.91
7	8.03	8.01	8.00	7.90	7.90	7.83	7.50	6.80
8	7.89	7.82	7.88	7.74	7.75	7.69	7.36	6.68
9	8.06	8.04	8.03	7.93	7.93	7.86	7.53	6.82
10	7.96	7.99	7.90	7.84	7.82	7.75	7.43	6.73
mean	8.03	8.01	8	7.9	7.9	7.83	7.5	6.8
CD at 5%	0.22							

Table no – 4.72 sensory score of flavour of soy flour optimized bread at refrigerated temperature (4°C)

Panelists	storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.83	7.85	7.83	7.82	7.74	7.66	7.25	6.65
2	7.97	7.96	7.91	7.87	7.88	7.80	7.37	6.77
3	8.01	8.03	8.02	7.98	7.95	7.87	7.44	6.83
4	7.93	7.93	7.89	7.87	7.83	7.75	7.33	6.72
5	7.81	7.78	7.71	7.72	7.67	7.59	7.17	6.59
6	8.03	8.03	7.99	7.96	7.92	7.84	7.42	6.81
7	7.90	7.90	7.86	7.84	7.80	7.72	7.30	6.70
8	7.76	7.72	7.74	7.68	7.66	7.58	7.17	6.58
9	7.93	7.93	7.89	7.87	7.83	7.75	7.33	6.72
10	7.83	7.88	7.76	7.78	7.72	7.64	7.23	6.63
mean	7.9	7.9	7.86	7.84	7.8	7.72	7.3	6.7
CD at 5%	0.2							

Table no-4.73 sensory score of over all acceptability of soy flour optimized bread at refrigerated temperature (4°C)

Panelists	storage periods (days)							
	0	1	2	3	4	5	6	7
1	7.92	7.93	7.91	7.86	7.80	7.76	7.41	6.85
2	8.06	8.04	7.99	7.91	7.94	7.90	7.53	6.97
3	8.10	8.11	8.11	8.02	8.01	7.97	7.61	7.04
4	8.02	8.01	7.97	7.91	7.89	7.85	7.49	6.93
5	7.90	7.86	7.78	7.76	7.73	7.69	7.33	6.78
6	8.12	8.11	8.07	8.01	7.99	7.94	7.58	7.01
7	7.99	7.98	7.94	7.88	7.86	7.82	7.46	6.90
8	7.85	7.79	7.82	7.72	7.72	7.68	7.32	6.77
9	8.02	8.01	7.97	7.91	7.89	7.85	7.49	6.93
10	7.92	7.96	7.84	7.82	7.78	7.74	7.39	6.83
mean	7.99	7.98	7.94	7.88	7.86	7.82	7.46	6.9
CD at 5% level	0.17							

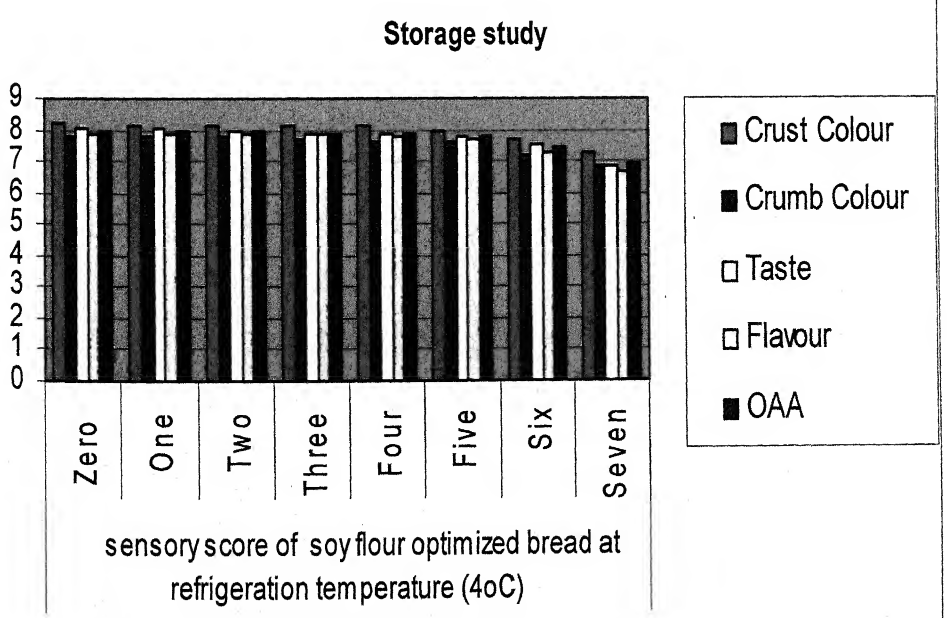


Fig no-4.10

The results (Table – 4.70) of present investigation indicated a decrease in crumb colour of bread on increasing the storage periods. The decrease in crumb colour upto 5 days was non-significant thereafter a significant ($P \leq 0.05$) decrease in crumb colour was observed. The crumb colour was in acceptable range up to 7 days of storage period.

The results presented in Table -4.71, showed a decrease in mean sensory score for taste of bread on increasing the storage periods at refrigeration temperature. The decrease upto 5 days was non significant thereafter a significant ($P \leq 0.05$) decrease was found. The taste was in acceptable range up to 7 days of storage.

The results presented in Table- 4.72, depicted a decrease in flavour of bread with an increase in storage period. The sample were analysed at an interval of 1 day for one weak. The decrease in the mean flavour scores up to 5 days was non significant thereafter a significant ($P \leq 0.05$) decrease in flavour was found.

From the results presented in Table- 4.73, showed that the over all acceptability of stored bread (at refrigerated temperature) did not differ significant upto 5 days of storage. Bread stored after 5 days showed significant ($P \leq 0.05$) variation in overall acceptability.

On the basis of the sensory evaluation, it is concluded that the bread may be stored successfully at 4 °C for 5 days.

Chapter 5

Summary and Conclusion

5. SUMMARY AND CONCLUSION

The present investigation was carried out to study the effect of incorporation of barley flour and defatted soy flour in bread. White flour was fortified with different proportions (95:5, 90:10, 85:15, and 80:20) of barley flour and defatted soy flour. The effect of incorporation of barley flour and defatted soy flour with white flour was carried out on functional, physical, chemical and sensory characteristics of blend and bread were studied. The optimization of gluten powder and surface active reagent (sodium stearoly-2- lactylate) were studied. The storage study of incorporated bread were made at room temperature and refrigerated temperature. The results are summarized as below:

1. The white flour, barley flour, defatted soy flour and gluten powder contained 10.27, 10.89, 5.48 and 7.05 percent moisture, 10.14, 10.40, 45.1 and 72.5 percent protein, gluten powder contained 0.68, 1.42, 0.87 and 0.70 percent fat and 0.58, 1.12, 5.12 and 1.02 percent ash, respectively. The white flour, barley flour and defatted soy flour showed 0.29, 3.65 and 3.60 percent crude fibre, 78.04, 72.52 and 39.63 percent carbohydrate, respectively.
2. The white flour, barley flour and defatted soy flour contained 2.165, 2.276 and 2.69 ppm pigment, 30.0, 26.30 and 251.4 mg/100g calcium, 138.9, 290, 493.10 mg/100g phosphorus and 2.48, 2.40, 10.30 mg/100g iron, respectively. The white flour contained 30.20 and 9.36 percent wet gluten and dry gluten, respectively.

3. The sedimentation value, polenshke value and water absorption capacity of white flour were 30.25 ml, 126 minutes and 62.20 percent, respectively. The incorporation of barley flour and defatted soy flour (5 to 20%) with white flour resulted decreasing effect on sedimentation value and polenshke value and the decrease was significant ($P \leq 0.05$). The incorporation of barley flour and defatted soy flour also increased significantly ($P \leq 0.05$) in water absorption capacity.
4. The inclusion of barley flour (5 to 20 percent) and defatted soy flour (5 to 20 percent) in white flour decreased the wet gluten and dry gluten significantly ($P \leq 0.05$). The incorporation of barley flour with white flour increased the wet / dry ratio of gluten but the increase was significant ($P \leq 0.05$) after 15 percent incorporation of barley flour. The incorporation of defatted soy flour decreased nonsignificant in wet /dry ratio.
5. The incorporation of barley showed a significant ($P \leq 0.05$) increase in protein after 15 percent level and in fat, ash content after 5 percent level. A significant ($P \leq 0.05$) increase in crude fibre and phosphorus while a significant ($P \leq 0.05$) decrease in carbohydrate content were obtained by inclusion of barley flour (5 to 20 percent) in white flour. A significant ($P \leq 0.05$) decrease in calcium and iron content after 15 percent incorporation of barley flour.
6. The effect of incorporation of defatted soy flour (5 to 20%) showed a significant ($P \leq 0.05$) increase in protein, calcium, phosphorus and iron while a significant ($P \leq 0.05$) decline in carbohydrate. Inclusion of 15 percent or more defatted soy flour showed a significant ($P \leq 0.05$) increase in fat, ash and crude fibre.

7. The incorporation of barley flour and defatted soy flour (5 to 20 percent) in white flour showed a significant ($P \leq 0.05$) increase in loaf weight and compression force (TPA) and a significant ($P \leq 0.05$) decrease in loaf volume, specific loaf volume, slice height and loaf height, respectively.
8. Increasing the level of gluten powder from 2 to 8 percent in blends containing 15 percent barley flour and 10 percent defatted soy flour caused a significant ($P \leq 0.05$) increase in loaf weight, slice height and loaf height. Increasing the gluten powder level (2 to 8 percent) showed a significant ($P \leq 0.05$) decrease in compression force (TPA) of bread. Inclusion of 2 to 8 percent gluten powder in 15 percent barley flour incorporated bread showed a significant ($P \leq 0.05$) increase in loaf volume after 4 percent level and specific loaf volume was nonsignificant. Addition of gluten powder with 10 percent defatted soy flour caused significant ($P \leq 0.05$) increase in loaf volume and a significant ($P \leq 0.05$) increase in specific loaf volume after 4 percent level.
9. The loaf weight, loaf volume, specific loaf volume showed a significant ($P \leq 0.05$) increase variation with inclusion of surface active reagent (sodium stearoly- 2-lactylate) from 0.50 to 2.0 percent level. The increase in surface active reagent (SSL) level showed a significant ($P \leq 0.05$) decrease in compression force of bread and a significant ($P \leq 0.05$) increase in slice height and loaf height after 1.5 percent level obtained from the blends containing (15 percent barley flour + 4 percent gluten powder) and a significant ($P \leq 0.05$) increase in slice height and loaf height in (10 percent defatted soy flour + 4 percent gluten powder).

10. The barley incorporated bread (0 to 20 percent) showed a significant ($P \leq 0.05$) increase in moisture, protein, fat, crude fibre and phosphorus content and a significant ($P \leq 0.05$) decrease in calcium and carbohydrate content in bread. The barley incorporated bread (5-20 percent) showed a significant ($P \leq 0.05$) increase in ash content after 5 percent level and a significant ($P \leq 0.05$) decrease in iron content after 5 percent level.
11. The defatted soy flour incorporated bread showed a significant ($P \leq 0.05$) increase in moisture, protein, calcium, phosphorus and iron content and a significant ($P \leq 0.05$) decrease in carbohydrate content of bread. The incorporation of defatted soy flour (5-20 percent) increased the fat, ash and crude fibre content of bread and the increase was significant ($P \leq 0.05$) for 15 & 20 percent level of soy flour.
12. On the basis of sensory evaluation, the bread prepared with 15 percent barley flour included with white flour showed a slight decrease in all parameters (crust colour, crumb colour, texture, taste, flavour and over all acceptability).
13. On the basis of sensory evaluation, the bread prepared with 10 percent defatted soy flour incorporated white flour showed slight decrease in crust colour, crumb colour, taste, flavour and over all acceptability of scores with the control bread. The texture scores were significantly lower ($P \leq 0.05$) with the control.
14. The results of sensory evaluation showed that the bread prepared with 4 percent incorporation of gluten powder in bread (15 percent barley fortified bread) and (10 percent soy fortified bread) found highest scores. A significant ($P \leq 0.05$) increase in crust colour, crumb colour, texture, taste flavour and over acceptability scores were observed on addition of 4 percent gluten powder.

15. On increasing the level of surface active reagent (SSL) from 0.50 to 2.0 percent, in barley fortified bread (15 % barley flour+4% gluten powder) showed a significant ($P \leq 0.05$) increase upto 1.5 percent surface active reagent in sensory characteristics namely crust colour, crumb colour, texture, taste, flavour and over all acceptability.

16. On the basis of sensory evaluation, the optimized soy fortified bread prepared with 1.0 percent surface active reagent level were found most suitable as it improved significantly ($P \leq 0.05$) in crust colour crumb colour, texture, taste, flavour and over all acceptability of bread.

17. The storage studies showed that barley bread may be stored successfully for 3 days at room temperature and for 5 days at refrigeration temperature. A significant ($P \leq 0.05$) increase in compression force (TPA) (hardness) after 3 days at room temperature and for 5 days at refrigeration temperature and a significant ($P \leq 0.05$) decrease in moisture content after 3 day at room temperature and for 5 days at refrigeration temperature. The compression force was significantly ($P \leq 0.05$) increase in defatted soy flour incorporated bread at both temperatures and a significant ($P \leq 0.05$) decrease in moisture content after 3 day at room temperature and for 5 days at refrigeration temperature.

18. On the basis of sensory parameter such as crust colour, crumb colour, texture, taste, flavour and over all acceptability, the storage studies showed that the barley and defatted soy flour incorporated bread may be stored for 3 days at room temperature and 5 days at refrigeration temperature.

On the basis of above studies it may be concluded that the barley flour (15 percent) and defatted soy flour (10 percent), gluten (4%), surface active reagent (SSL) (1.5 percent for barley bread and 1.0 percent for defatted soy flour) may be included to obtain nutritionally rich, good quality and consumer acceptable bread.

Chapter 6

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Appendix

Appendix-1 Sensory Card

Hedonic Rating Test Date-
Product-
Name –
Designation-

Kindly evaluate bread. the evaluation may kindly be made on the basis of 9-point hedonic scale. An honest expression of feeling will help us.

Code No	Crust Colour	Crumb Colour	Texture	Taste	Flavour	Over All Acceptability

Hedonic Scale	**Organoleptic Score**
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Remarks:

Signature:

VITA

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